OWNER'S INTERFERENCE IN REVERSE AUCTION BIDDING TO SKEW A FREE MARKET

A Thesis

by

SUSHIL VINAY CHAUDHARI

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE

December 2009

Major Subject: Construction Management

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Approved by:

Chair of Committee,	John Nichols
Committee Members,	John Peterson
	Anne Nichols
Head of Department,	Joe Horlen

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ABSTRACT

Owner's Interference in Reverse Auction Bidding to Skew a Free Market. (December 2009)

Sushil Vinay Chaudhari, B.E., College of Engineering, Pune

Chair of Advisory Committee: Dr. John M. Nichols

Reverse auction bidding is an online auction system. A purchaser's primary objective in using a reverse auction is to obtain the lowest possible bid for goods and services on a construction project. With this type of bidding, it is normal that the purchaser will only consider price, instead of a bidders' work history and experience. As a reverse auction is an online service, the common misperception is that a purchaser can reach a broader market to obtain the lowest possible price. It is a controversial bidding system. No previous research has been undertaken by the Texas A&M University Reverse Auction Bidding study group into potential owner interference with the bidding system for a reverse auction.

Six bidders were asked to participate in the Reverse Auction Bidding process for a series of construction projects in Houston. Each participant was also asked to complete a Keirsey Temperament Sorter Test type I and II to determine each participant's personality. After the tests, the six participants competed in an online reverse auction bidding game. The primary objective of this research is to analyze the impact of an owner's interference in a reverse auction bidding scenario. In this test, one of the six bidders acted as the owner's surrogate to interfere with an ethical process and reduce the owner's costs. The other five bidders were unaware of the surrogate's role in the bidding. The primary directive given to the surrogate bidder was to drive down the cost of the projects. The results for the research study show that the owner's surrogate can affect the bidding process. Interference results in reduced returns for the bidders when compared to an uncompromised bidding scenario. It is clear that the method used is unethical.

ACKNOWLEDGEMENTS

To begin with, I would like to thank Dr. John Nichols for encouraging, helping, and constantly supporting me throughout my master's program at Texas A&M University. Without his guidance I would not have been able to complete my master's program. He stood by me until I succeeded.

When I completed my Bachelor's degree in engineering, I never knew that one day I would go on to pursue a Master's degree in construction management. Texas A&M University has provided the best environment one could hope for – committed professors, excellent research options and intelligent colleagues. Being part of this institution has allowed me to challenge myself in ways that I never dreamed possible. Thank you, Texas A&M University.

I also want to sincerely thank my committee members Dr. Anne Nichols and Dr. John Peterson, whose guidance throughout master's program has been invaluable. Thank you so much.

Last, but not the least, I want to thank my parents without whom I am nothing. Their support has meant so much to me.

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CHAPTER I
INTRODUCTION

Today, the construction industry is a competitive business with an excellent supply of general contractors, subcontractors, dealers, and suppliers. Recently there has been an introduction of a new system of bidding, Reverse Auction Bidding (RAB), which has created a great deal of dispute. Some claim that RAB will drive costs down for the purchaser; this leads to a lively debate about this method of bidding. The construction industry has been tackling the issues of rising costs, increasing competition, varying degrees of experience and quality of work, high failure rates and marginal rates of return, but a significant number of construction professionals question whether RAB will achieve the nominal objective. This study extends the research work undertaken on RAB using game theory at Texas A&M University since 2004.

In traditional bidding, contract procurement takes place in the form of a sealed bid, which was opened at a specified time and a specified place. Both private owners and governmental agencies have begun to adopt RAB in an effort to drive down the cost of construction. In RAB, each pre-qualified bidder is able to see what the current price for the job is and determine if they are able and willing to do the specified work at a lower prize. The bidders submit initial prices, which are given a ranking, and all participants are informed of their ranking relative to other bids. Bidders can resubmit lower prices as many times as they wish until the specified closing time. Once the auction is closed, all bidders are notified of the final bid rankings and the dollar value of the winning bid. A slightly altered version of this method is used at Texas A&M University to reduce the game time to a reasonable period.

This thesis follows the style of *International Journal of Construction Education and Research*.

According to purchasers, RAB forces contractors to present their lowest prices. Opponents of Reverse Auction Bidding claim that construction services cannot be treated as commodities and therefore should not be auctioned. They state that construction projects are unique and are subject to variables that are not encountered in the controlled environment of manufactured goods (Knoll & Thompson, 2002). RAB can reduce contractor profit, which may in turn compromise safety and quality at the job site (Angelo, 2002). In addition, Reverse Auction Bidding presents the opportunity for bid shopping or other forms of bid manipulation. One common complaint of RAB is that many firms will be awarded contracts for work that unethical and do not contribute to the long-term interest of either the buyer or the seller' (Harbert, 2003). This research study extends the prior RAB work to determine whether a purchaser can affect all of the bidder's profit margins by introducing a surrogate bidder into the game.

Problem Statement

This study evaluates the ability of a purchaser's surrogate in a Reverse Auction Bidding process to skew the market with the essential objective of reducing the profit margins of the bidders when compared to an open and transparent competition. The research used game theory to analyze bidder's behavior variations during the game as well as personality testing to determine if there is a relationship between characters and bidding behavior.

Research Problem

A surrogate bidder is introduced into a Reverse Auction Bidding game. The bidding game uses the construction of flat concrete on ground house slabs to model a real world scenario. The research question is: "Whether a surrogate bidder reduces the profit margins for all bidders?"

Sub-problems

- Irrespective of the overall change in bidding behavior resulting from the surrogate interference, does the personality type have an impact on the profit made by an individual bidder relative to the other bidders' profits?
- What skew does the surrogate introduce to the market?

Research Hypothesis

Can interference by a purchaser's surrogate affect the result of reverse auction bidding process, specifically the profit margins of all other bidders?

Limitations and Delimitations

The scope of research study will be limited to following factors:

- The study is limited to the current graduate students of Construction Science Department at Texas A&M University.
- This study was performed in a controlled setting, limiting the variables that exist in the market place, as well as the risk related to the daily transaction of business. The controlled setting was necessary in order to establish clear lines for evaluating participant behavior patterns.
- This study does not address any misprint errors, omissions and miscalculations that are caused due to participant's online bidding process.
- The surrogate's behavior is clearly unethical and illegal; these issues are set aside for the research.

Significance of the Study

The use of Reverse Auction Bidding is growing within the procurement section of the construction industry. Previous research has identified behavior patterns of bidders during the game play stretching over seven "theoretical" weeks. This study looks at the changes to the game play introduced by an unethical behavior on the part of a purchaser. This behavior provides a model for review of Reverse Auction Bidding for evidence of such behavior in a real situation.

Definitions

A number of these definitions are derived from work by Van Vleet (2004).

Bidder – An entity that submits bid. In this game, there are usually three to ten bidders.

Bid – A single entry into the game that represents a legally acceptable offer to complete the work assuming the bidder has been prequalified.

Coca Cola Index - An early study in the Reverse Auction Bidding game looked at the range of prices paid for a liter of Coca Cola around the world. This index ranged from 1 to 3.5. This index is used to provide an upper limit to the bidding process in much the same manner as published trade rates offer a suggested range of fees. This limit was suggested by L. Feigenbaum of Texas A&M University.

Collusion – A secret agreement between two or more parties for a fraudulent, illegal, or deceitful purpose.

Herfindahl Index - a measure of the size of firms in relationship to the industry and an indicator of the amount of competition among them. It is defined as the sum of the squares of the market shares of each individual firm. As such, it can range from 0 to10,000, moving from a very large amount of very small firms to a single monopolistic producer. Decreases in the Herfindahl index generally indicate a loss of pricing power and an increase in competition, whereas increases imply the opposite. The Department of Justice considers Herfindahl indices between 1000 and 1800 to be *moderately concentrated* and indices above 1800 to be *concentrated*. As the market concentration increases, competition and efficiency decrease and the chances of collusion and monopoly increase.

Loss – A negative return applied to a business undertaking after all operating expenses have been met.

Lump Sum offer – A tender submitted for a lump sum amount in the game assumed to be for a fixed price.

Pre-Qualified – The process of declaring competent or capable or to certify in advance.

Profit – A positive return received on a business undertaking after all operating expenses have been met.

Purchaser – Either an owner or owner's representative who organizes the bid or tender document.

Reverse Auction Bidding - Single or multiple-item, open, descending-price auction. The initiator specifies the opening bid price and bid decrement. Each bidder submits a successively lower bid. At the end of the auction, the bidder with the lowest bid is assumed to win the auction.

Second Bidder Issue – Nichols (Personal communication, 2009) has postulated that the lowest bidder in Reverse Auction Bidding is seeking to undercut the second bidder by the smallest quantifiable fragment, if the bidder understands the principles of tacit collusion.

Sherman Antitrust Act - The act, based on the constitutional power of Congress to regulate interstate commerce, declared illegal every contract, combination (in the form of trust or otherwise), or conspiracy in restraint of interstate and foreign trade. According to Nichols (Personal communication, 2009), the problem is tacit collusion does not fit within the meanings of the act, thus leading to the debate about the legality of RAB between contractors who consider it illegal or unethical and economists who accept the converse.

Tacit Collusion - Seemingly independent, but parallel actions among competing firms (mostly oligopolistic firms) in an industry that achieve higher prices and profits, much as if guided by an explicit collusion agreement. Also termed implicit collusion, the distinguishing feature of tacit collusion is the lack of any explicit agreement. The key is that each firm seems to be acting independently, perhaps each responding to the same

market conditions, but the end result is the same as an explicit agreement. This should be contrasted with explicit or overt collusion that does involve a formal, explicit agreement. Tacit collusion is observed in Reverse Auction Bidding, and is potentially related to the Second Bidder Issue.

Tender – An alternative term for a bid.

Tender or Bid document – The document prepared to seek bids or tender offers.

Tenderer - An alternative term for a bidder used in English Contracts.

Traditional Bidding – In this type of auction all bidders simultaneously submit bids in such a way that no bidder knows the bid of any other participant. The highest/lowest bidder is assumed to be awarded at the price submitted provided no other contracts opened on the decision process.

Winners Curse - Problem faced by uninformed bidders or poor game players. For example, in an initial public offering uninformed participants are likely to purchase larger allotments of issues that informed participants know are overpriced.

CHAPTER II
LITERATURE REVIEW

This literature review examines the Bidding System and the game used at Texas A&M University to model RAB in an academic setting. E-sourcing is considered as a popular tool for procurement with the far-reaching growth of the internet. In recent years, the Reverse (decreasing bids) Auction Bidding process has become an accepted tool, which facilitates competitive and collaborative interactions among buyers and suppliers through the use of online negotiations (Richard & Elena, 2006).

Reverse Auction Bidding ("RAB") is a process in which a buyer of goods and services continues to solicit bids from sellers until the buyer is satisfied they have received an acceptably low price although time does become a problem that ultimately limits the bidding process. In a conventional bidding method, general contractors submit their bids, or pre-selected general contractors solicit bids from subcontractors, and there is no opportunity for subsequent bidding after the specified time for bid opening. The unique feature of Reverse Auction Bidding process is that it communicates the current lowest bid to all bidders and invites them to underbid it. This is called transparency in economics. In economics, a market is transparent if much is known by many about: What products, services, or capital assets are available, What price or prices one can offer, Where, and the terms of the contract. There are two types of price transparency: 1) I know what price will be charged to me, and 2) I know what price will be charged to you. The two types of price transparency have different implications for differential pricing. In a RAB, the bid price continues to decrease as long as one bidder is willing to underbid the current lowest price. In other words, it is the reverse of typical auctions where prospective buyers bid upward (Minnesota Department of Administration, 2003).

Following are the five steps recommended for executing a successful reverse auction:

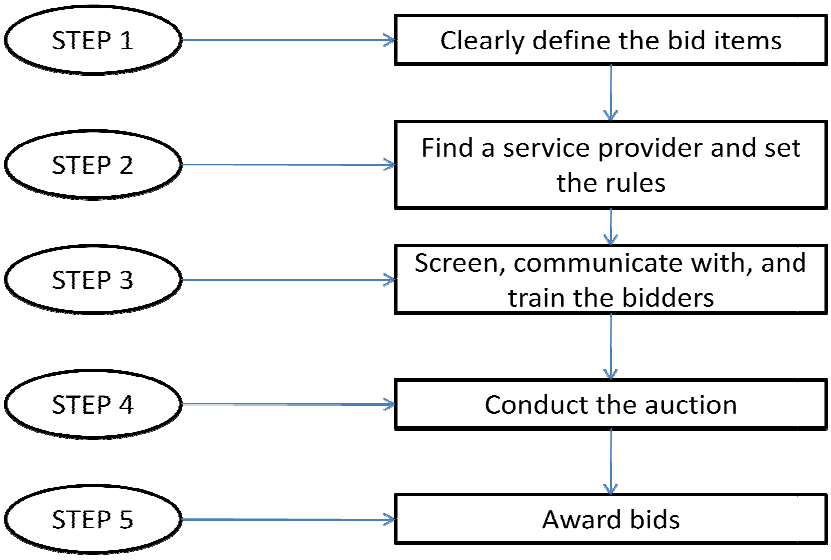

Figure 1 Reverse Auction Bidding (Davies 2003; Wagner and Schwab 2003; Smeltzer and Carr 2002)

The characteristics of the five steps as shown in figure 1 are:

Step 1: Clearly define the bid items

This step is similar to traditional purchasing. Specifications, drawings, and bid documents are prepared by the purchaser to describe the goods/services sought. Ambiguity in these documents should be reduced as reduced ambiguity increases the chances for a successful transaction.

Step 2: Find a service provider and set the rules

Buyers should screen service providers and examine their abilities and past performance over a wide range of goods and services. Auction execution will be greatly enhanced by

carefully constructed bidding rules, market clearing rules, and information disclosure rules.

Step 3: Screen, communicate with, and train the bidders

Bidders should be screened to ensure the quality of the deliverables. It is a good practice for the buyer to ensure training to the participating bidders before the auction.

Step 4: Conduct the auction

Buyers should ensure the participation of at least three qualified bidders before starting the auction. The value of the transaction should be considered while deciding over the auction duration.

Step 5: Award bids

The buyer should finalize the transaction with the successful bidder in a reasonable time period following the closing of an auction. The transaction can be finalized within a few hours or days from the bid closing time.

In the process of "RAB", bidders are generally required to preregister with the auction service provider to receive training in how to participate. They must agree to abide by the rules of the auction service provider. Bidders are notified when the bidding period opens and are informed about the auction duration. They submit their prices remotely from their offices. During the auction, the bidders can view the status of their bid by watching the current lowest price as it appears on the web site in real time. Similarly, owners also can watch the bidding processes (Thomson & Knoll, 2002). The identity of the bidders is not revealed to other bidders and, depending on the auction rules, may not be revealed to the owner.

Nevertheless, Reverse Auction Bidding still remains controversial both within buying organizations, among suppliers, and among the academics who study the problem. This bidding practice has recently gained popularity among both private and public owners and has found its way into the procurement of construction services. Proponents of reverse auctions claim that this practice promotes competition and allows buyers to

achieve the lowest possible price, thus benefiting the public at large. They believe that it will drive down the cost of the project and will save the large amount of money for owner. Opponents claim that this practice is nothing more than a modern form of bid shopping. They believe that it is harmful to the construction industry because it creates an unhealthy business environment, eliminates the benefits of the bid system, promotes lower standards of quality performance, delays project completion and reduces job site safety (Horlen, Eldin & Ajinkya, 2005). In my opinion, RAB is an acceptable economical practice because each of the pre-qualified participants is able to see the current price for a given project with the opportunity to place a lower bid within a specified time limit. With RAB, the system is instantly efficient because all of the information has been revealed to all participants.

It may possible for the owner to put a fake bidder in the RAB process with the intention of driving down the costs. This is unethical behavior and illegal in most places because then RAB will not be a transparent process and the bidder who agrees to accept bid lower than the cost bade by fake bidder likely to get lesser profit than what minimum he should have got. This cannot happen in conventional bidding because all bids are opened at one time and whoever has minimum bid gets the project. Figure 2 shows a typical screen in an online Reverse Auction Bidding system. In this case, the screen is from the research game.

Rob Van Vleet's Reverse Auction Bidding - ALL CURRENT BIDS [ALL CURRENT BIDS] [ALL COMPLETED JOBS] [MY BIDS INFO] [LOGOUT]

Now : Day56 (No more days!, Experiment expired

My Active Bids

JOB#	LOCATION	CURRENT PRICE	CURRENT BIDDER	TIME REMAINING	MY LOWEST BID AMOUNT	OUTBID
There are no my active bids !!!						

My Jobs in Progress

JOB#	LOCATION	Bid Amount	Job Start Date	Delays	Construction days	Cost to Date
There is no work in progress !!!						

My Completed jobs

Job#	Site	Bid Date	Bid Amount	Cost	Profit	Start day	End day	Rainy days	Profit Rate
There are no finished jobs									

My summary

- Current Spare Capacity For Additional Work : 3 [Your total capacity : 3 (initial capacity : 3, Added capacity by bank guarantee : 0]
- Current Finalcial Condition : $ 40000 (No money paid to initiate work, No money paid in middle of job)
  [= Capital money [$40000] + Profits from completed jobs - Costs of current jobs in progress - Bank Guarantee Fee($500/loan)]
  Current My Total Bank Guarantee Fee : $ 0

Figure 2 Screen Capture of My Bids Information Screen

In a reverse auction, a buyer contracts with a market maker to help make the necessary preparations to conduct the reverse auction. This includes: finding new suppliers, training new and incumbent suppliers, organizing the auction, managing the auction event, and providing auction data to buyers.

The prices that buyers obtain in the reverse auction reflect the narrow market which it created at the moment in time when the auction is held. Narrow market is defined as an inactive market which displays large fluctuations in prices due to a low volume of trading. Thus, it is possible that better value i.e. lower prices, as well as better quality, delivery performance, technical capabilities, etc. could be obtained from suppliers not engaged in the bidding or by other means such as collaborative cost management and joint process improvement.

The buyer may award contracts to the supplier who bid the lowest price. Or, a buyer could award contracts to suppliers who bid higher prices depending upon the buyer's specific needs with regards to quality, lead-time, capacity, or other value-adding capabilities. However, buyers frequently award contracts to incumbent (i.e. current) suppliers, even if prices are higher than the lowest bids, because the switching costs to move work to a new supplier are higher than the potential savings that can be realized. This outcome, while very attractive to buyers, is often strongly criticized by both new and incumbent suppliers.

Reverse auctions are used to fill both large and small value contracts for public and private commercial organizations. In addition to items traditionally thought of as commodities, reverse auctions are also used to source buyer-designed goods and services, and has even been used to source reverse auction providers.

Jap (2003) provides quantitative evidence that suppliers tends to become suspicious about buyers opportunism, which adversely affects the owner – bidder relationship in a Reverse Auction Bidding. Jap (2007) further reports that only 5 percent of the people they interviewed suggested that reverse auction process can improve relationships which means that rest 95 percent will hamper it. Engelbrecht – Wiggans (2007) argue that as there are repeated interactions between owner and bidders in the whole bidding process, where bidder's behavior gets affected by issues external to the auction like gaining a strategic position over other bidders and the buyer always an economic issue. Jap (2007) conducted research on aggressiveness of bidder by considering various factors such as total number of bids a supplier make, the rate of making bids and degree of price concessions they offer and concluded:

"Suppliers who are interested in making specific investment with buyer and also those who want to develop long term relationship with the buyer will submit few bids, bid at greater intervals, and make less reduction in profit margin in the entire bidding process compared to rest of the suppliers."

"Suppliers who frequently submitted bids and made heavy reductions in profit margin have lower propensity of relationship post-auction with the buyer which suggest that reverse auction is a "negative price haggling" process."

"Strategic bidding behavior of suppliers in which they appear to trade off potential economic and rational investments is long term exchange with short term pricing concessions."

There were several other key findings regarding reverse auction in Jap's (2007) research:

"As the number of bidders in the auction increases, suppliers lose interest in reverse auction bidding process and tend to bid less aggressively."

The reasons for this issue are yet to be determined but the researcher indicates that bidders become skeptical and start to assume the presence of non-qualified bidders bidding in the reverse auction process. Further, Jap (2007) says that there may be possibility that if number of supplier exceed in bidding process, bidders may lose interest, refuse to bid against non-responsible bidders and start looking for alternative buyers. Decreases in the Herfindahl index generally indicate a loss of pricing power and an increase in competition, whereas increases imply the opposite. The Department of Justice considers Herfindahl indices between 1000 and 1800 to be *moderately concentrated* and indices above 1800 to be *concentrated*. As the market concentration increases, competition and efficiency decrease and the chances of collusion and monopoly increase. The fewer the number of competitors in a market the higher the index score (Van Vleet, 2004).

"Total number of cumulative bids submitted in the competition, raise in total bids, submission rate of bids and price concession offered by bidders suggest that bidders bidding in the competition were responsive."

The bidding aggressiveness changes with respect to number of bidders and total duration of the event of reverse auction. According to Staw (1976), "Bidding aggressiveness is responsible to total number of bids by others may represent a psychological escalation of commitment". Jap (2007) states that "Supplier's frequency of bidding decreases with

increase in duration of event of reverse auction which could affect overall price savings for the buyer."

In summary, there appears to be a lot of unresolved issues for Reverse Auction Bidding in terms of the ethics, operation, and interference. Whilst this issue is quite common for new technologies, on bidding methods, the concerns about true transparency will remain for some time until the industry matures.

The Keirsey Temperament Sorter Test provides a measure of personality. This research extends on work by Chouhan (2009) on bidder's personality and the impact on a RAB game. Table 1 lists the different personality types of the Keirsey Temperament Sorter.

Table 1 Different Personality Aspects and Temperaments as per KTS

	Temperament	Role	Role Variant
Introspective (N)	Idealist (NF) *Diplomatic*	Mentor (NFJ) *Developing*	Teacher (ENFJ): *Educating*
			Counselor (INFJ): *Guiding*
		Advocate (NFP) *Mediating*	Champion (ENFP): *Motivating*
			Healer (INFP): *Conciliating*
	Rational (NT) *Strategic*	Coordinator (NTJ) *Arranging*	Field marshal (ENTJ): *Mobilizing*
			Mastermind (INTJ): *Entailing*
		Engineer (NTP) *Constructing*	Inventor (ENTP): *Devising*
			Architect (INTP): *Designing*

Table 1 Continued

	Temperament	Role	Role Variant
Observant (S)	Guardian (SJ) *Logistical*	Administrator (STJ) *Regulating*	Supervisor (ESTJ): *Enforcing*
			Inspector (ISTJ): *Certifying*
		Conservator (SFJ) *Supporting*	Provider (ESFJ): *Supplying*
			Protector (ISFJ): *Securing*
	Artisan (SP) *Tactical*	Operator (STP) *Expediting*	Promoter (ESTP): *Persuading*
			Crafter (ISTP): *Instrumenting*
		Entertainer (SFP) *Improvising*	Performer (ESFP): *Demonstrating*
			Composer (ISFP): *Synthesizing*

Table 2 provides the meaning of the letters used to define different personality types.

Table 2 Meaning of Group of Letters in Personality Code

Letter	Name	Meaning
E	Extraversion	Feel motivated by interaction with people. Tend to enjoy a wide circle of acquaintances, and *gain* energy in social situations

Table 2 Continued

Letter	Name	Meaning
N	iNtuition	More abstract than concrete. Focus attention on the big picture rather than the details, and on future possibilities rather than immediate realities
F	Feeling	Value personal considerations above objective criteria. When making decisions, often give more weight to social implications than to logic
J	Judgment	Plan activities and make decisions early. Derive a sense of control through predictability
I	Introversion	Quiet and reserved. Generally prefer interacting with a few close friends rather than a wide circle of acquaintances, and *expend* energy in social situations
P	Perception	Withhold judgment and delay important decisions, preferring to "keep their options open" should circumstances change

Table 2 Continued

Letter	Name	Meaning
T	Thinking	Value objective criteria above personal preference. When making decisions, generally give more weight to logic than to social considerations
S	Sensing	More concrete than abstract. Focus attention on the details rather than the big picture, and on immediate realities rather than future possibilities

CHAPTER III
RESEARCH METHODOLOGY

Research methodology has been divided into three subcategories:

Part 1 – Data Collection, Step 1

Part 2 – Data Collection, Step 2

Part 3 – Data Collected

Data Collection Step 1: Keirsey Temperament Sorter

Each individual was asked to take the Keirsey Temperament Sorter (KTS) Test and the results were analyzed using standard procedures. The information about personality type of a bidder involved in the game process was collected in order to compare the personality types against the returns made in the game. The KTS Test covers all the personal characteristics and long-term behavioral patterns as defined by two different definitions of the personality. It evaluates public, social, or behavioral characteristics of a person along with his private, central, and inner core values. KTS also defines the systematic analysis of personality aspects that include the individual's interests, orientation, values, self image, and social roles. (Chouhan, 2009). The individual bidder's personality type is shown in table 3.

Table 3 Individual Bidder's Personality Type

Bidder's User Name	Temperament Sorter Personality Code	Temperament	Role	Variant Role
Concrete Company	ISTJ	Guardian *(Logistical)*	Administrator *(Regulating)*	Inspector *(Certifying)*
Copper Company	ISFJ	Guardian *(Logistical)*	Conservator *(Supporting)*	Protector *(Securing)*

Table 3 Continued

Bidder's User Name	Temperament Sorter Personality Code	Temperament	Role	Variant Role
Driver Company	ISFJ	Guardian *(Logistical)*	Conservator *(Supporting)*	Protector *(Securing)*
Log Company	ISFJ	Guardian *(Logistical)*	Conservator *(Supporting)*	Protector *(Securing)*
Pliers Company	ESTJ	Guardian *(Logistical)*	Administrator *(Regulating)*	Supervisor *(Enforcing)*
Rove Company	ESTJ	Guardian *(Logistical)*	Administrator *(Regulating)*	Supervisor *(Enforcing)*

Data Collection Step 2: Data Set from Simulation

Reverse Auction Bidding software was designed by Van Vleet, (2004) using an ASP interface and Microsoft Access database so that all the bidders could bid from remote locations over the internet. The design of the software is such that the data collected is aggregated at a central and single location using Microsoft Access database and then transferred into Microsoft Excel for further analysis. This data is now collected using a SQL Server 2005 database to allow simultaneous access for multiple projects. This system was developed for Gregory's research in 2008.

The Scenario

The bidding process was designed and developed to involve two categories in the bidding game; the owner and the bidder. The owner's profile in this game process is:

The owner is an established homebuilder in the Greater Houston area and he is looking forward to some new developments in his area of expertise. In this entire game process

the job is really easy and manageable as it requires the builders to construct only one type of home which requires pouring one type of slab for each home.

The profile of the bidder in this game process is:

The bidder's role is to submit his bids during the game process to gain business against his competitors. All bidders are provided with an initial bank amount of $40,000. They are supposed to submit their bids while considering the realistic scenarios such as rain delays, travel and delivery charges, delays due to distant projects and other variables that affect the day to day business particularly in the construction industry. The main objective for the bidders during the game process is to generate maximum profit.

Game Details

The simulation contains a set of instructions provided to the bidders in the game process. It also includes the details, description and variables that affect the project and its duration.

1. The total duration of the game scenario in this setting will be a maximum of nine consecutive weeks.
2. All bidders initially have an equal dollar amount of $40,000 available in their bank accounts.
3. The base cost for each job has been estimated by a competent estimator as $10,000. This cost does not include any applicable travel and delivery charges. The amount of these excluded costs will be posted on web site for each job along with some other relevant details such as job site address, access information and other details necessary to commence the job on time.
4. The default duration to complete each job is five scenario days of construction time, excluding rain periods.
5. Work week begins on Monday and ends on Saturday. The work week is six days long.
6. All bidders are limited to work on three jobs per week. However, if they desire to work on more than three jobs per week they then have to take a loan out to

finance for each additional job. The additional borrowing charges are $500 which will be charged automatically every time they borrow a loan irrespective of whether they win a job or not.

7. Since the base cost for all jobs is $10,000, and the default duration is five days, each bidder makes $2000 per day for all jobs. This construction cost will be accrued on daily basis. In addition, travel expenses and delivery charges are also accrued on a daily basis, as is determined by the job site location.
8. The main office of the owner is located in Sugarland and the travel and delivery expenses will be determined on the basis of distance of job site from this location as all subcontractors have offices within a mile of the owner.
9. The minimum acceptable return on investment derived from long term construction industry standards is 10 percent.
10. Payment for work is scheduled to be delivered at the completion of the fifth construction day.
11. Start of bidding times will be determined by a consensus of all participants. They will have exactly 15 minutes to place bids.
12. The main objective of all the bidders is to maximize their profits, whilst maintain bank confidence and acceptable liquidity.

Rain Delay

1. There will be no additional charges for any delays. Houston has a significant amount of rain during the months of May, June, and July which is the national construction period for the game.
2. Any rain delays will cost one day of construction for that specific job. However, because no work is being performed, it also means that no costs are being incurred. This condition is the most contagious as it assures other work is available.
3. Statistics providing information for the probability of rain in the Houston area in mid-June through late-July is collected from National Oceanic and Atmospheric Administration (NOAA, 2009). It stated that Houston has a probability of

receiving approximately 35 percent of rains in this duration. Consequently, there is a 35 percent chance of delay in construction on any given day. This statistic is used to derive a rain delay vector.

Figure 3 shows the probability of rain for Houston during the game period.

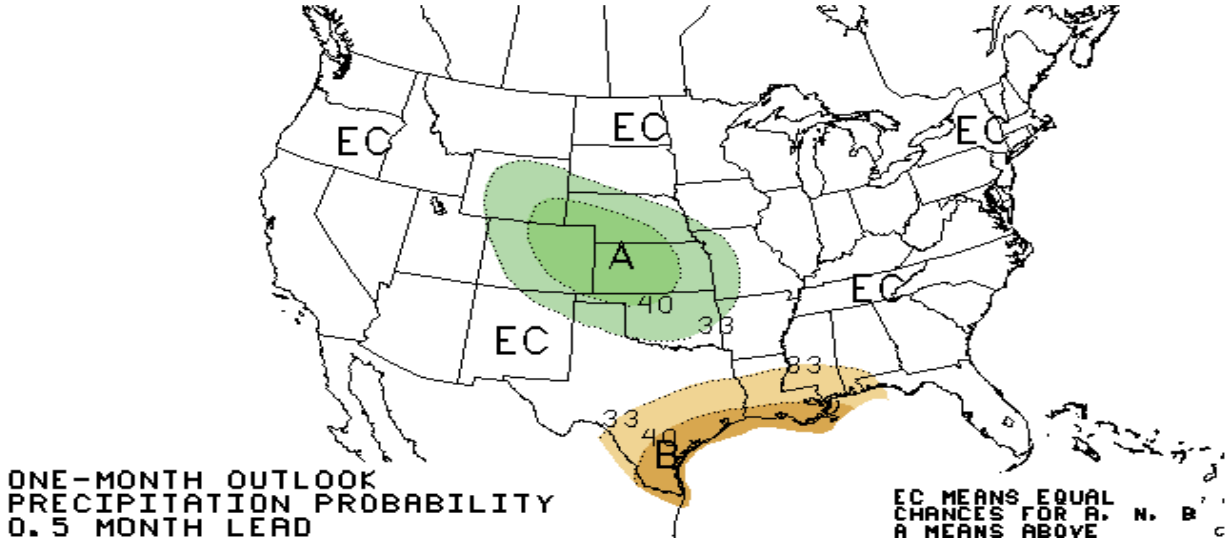

Figure 3 Probability of Rain in Houston Area in Mid June Through late July

Rain can have a significant impact on the progress of the reverse auction bidding game. Bidding strategies must vary as rain causes delays on completion of some jobs for the current construction week. The alternative is to take a bank loan that provides a value for a lost rain day at $500. Delays caused due to rain can reduce the default capacity of the bidder to bid three jobs every week. A job is listed as an Incomplete Job if it is not completed in the same week in which it was bid due to rain delays. A bidder has the nominal capacity to bid for only two additional jobs for that week if there is one incomplete job in the current week (excluding any bank loan). The rain delay was directly linked to site locations on a particular day. The rain data for week 1 is shown in table 4.

Table 4 Rain Data for Week 1

Day	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Monday	1	0	0	0	1	0
Tuesday	0	1	1	0	0	0
Wednesday	0	0	0	0	0	0
Thursday	0	0	1	0	0	1
Friday	1	0	0	0	1	1
Saturday	0	0	0	0	0	0

Site Locations

The six development areas selected were Brookside Village, Piney Point Village, Highlands, Jersey Village, Bunker Hill Village, and Richmond (Van Vleet 2004). These areas are shown in figure 4.

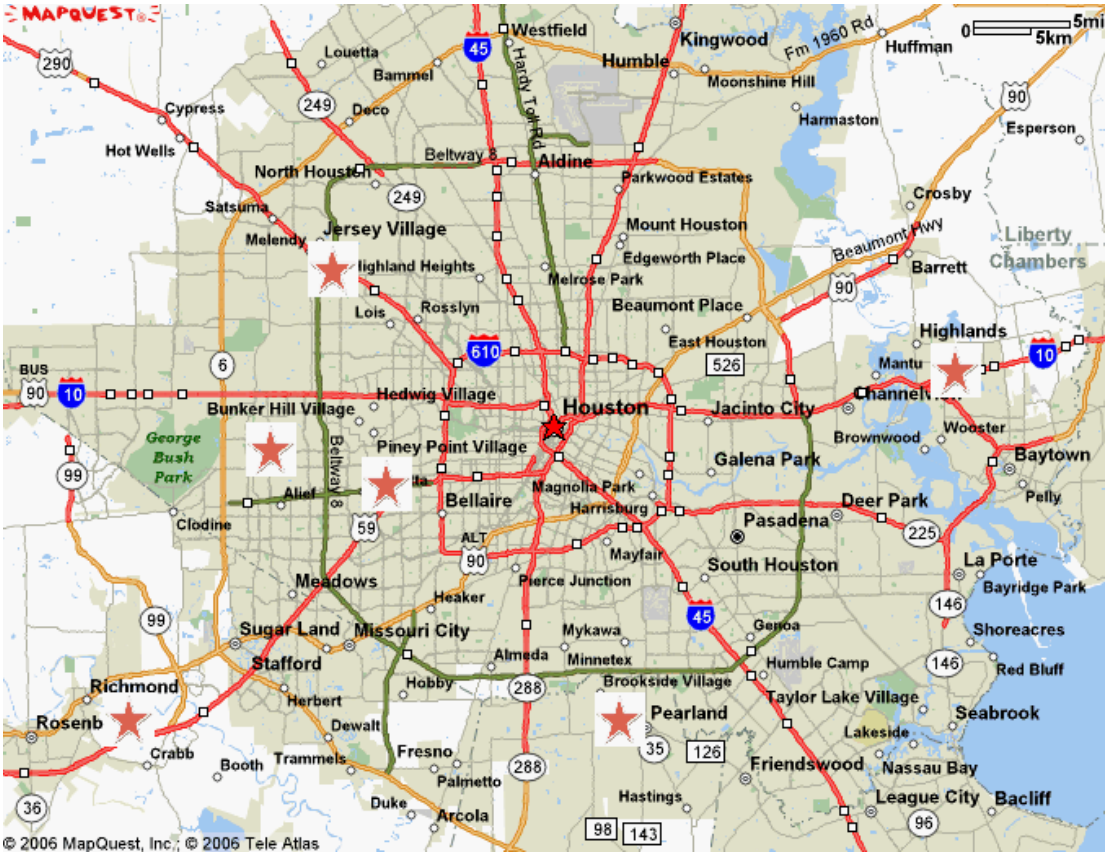

Figure 4 Site Locations

Source: (MapQuest, 2009)

As mentioned earlier, travel and delivery costs are dependent on the distance of these locations from owner's office in Sugarland. Each of these locations has different project costs that include construction costs as well as travel and delivery costs.

The six selected development areas and their respective distances from the Homebuilder's main office are listed in table 5. Table 5 also shows the travel and delivery costs associated with these locations.

Table 5 Development Areas Distance from Home Builder's Main Office in Sugarland, Houston and Their Respective Travel Cost and Delivery Cost

Site #	Location of Development	Distance from Sugarland (miles)	Travel Cost ($)	Delivery Cost ($)	Total Cost ($)
Site 1	Brookside Village	42	858	624	1482
Site 2	Piney Point Village	24	495	360	855
Site 3	Highlands	70	1452	1056	2508
Site 4	Jersey Village	40	825	600	1425
Site 5	Bunker Hill Village	27	561	408	969
Site 6	Richmond	14	297	216	513

Web Site Description

In 2004, Robert Van Vleet created a website using ASP programming which was connected to a database using Microsoft Access. This site was used to run the online simulation of the bidding game. This website allowed participants to input their bid information, and would also collect the data for the analysis of the bidding behavior. Details of the ASP programming are given in the paper by Gregory (2006), and Shanker (2005). Gregory (2006) encountered significant problems with the Microsoft Access database as he tried to get the bidders online at once. An alternative SQL Server 2005 database was configured for the game site.

A domain location was created on the Texas A&M University's College of Architecture server to host the reverse auction game where each participant enters the system and they assigned a login screen with username and password entry boxes. Each participant was provided with a unique login name, being: Driver, Pliers, Concrete, Rove, Copper, and Log. Each participant had a unique password to control access to the site. These specific login name and password allowed each participant to enter the website. However, it limited their access to the information that was relevant only to their bidding. After starting their login session, the participants were taken to the "All Current Bids" screen.

Figure 5 shows the "All current bids" screen.

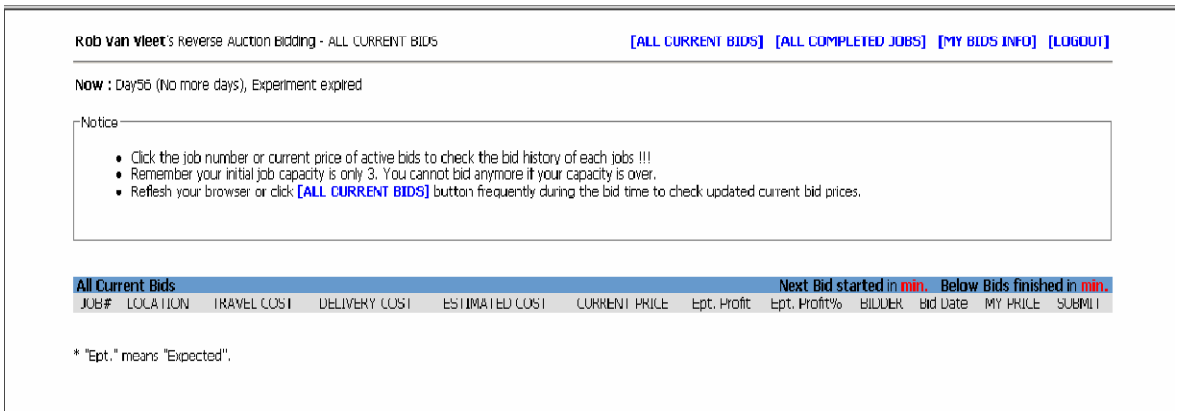

Figure 5 Screen Capture of All Current Bids Screen

This screen provides bid information such as location and related cost for each job. The information provided on this page was identical for all participants. It contained all of the information pertaining to the available jobs for that week. This screen provides the information about the current bid price, estimated profit and name of the current bidder. This screen served as the bidding screen where participants would enter their bids in the white boxes located under the "My Price" column.

Random dice rolls using three dice were used to determine the number of jobs that were available each week. Previous studies had also used dice to determine the number of jobs per week.

In the design of the web page, allowances made such that the bidding process should minimize the erroneous information given to the bidders. The relevant information includes the cost of the job, all current bids, and the bidder's company name. In addition, no bids could be placed before bidding time was set to commence, or after bidding was closed. Bidding occurred for a 15 minutes period, the system was closed for 5 minutes.

Bidders were instructed to refresh computer screens to keep abreast of current status of the active bids because of the limitations of the internet browsers. One major modification required in the website for future bidding process is the introduction of automatic refresh application of the web page, which automatically updates itself at previously decided fixed interval of time. This helps to keep the bidders regularly updated about the bid status and its relevant bid price. This identified problem of timing of bids over the internet as one of the ethical issues that should be considered.

As discussed earlier, participants were restricted to bid on only three jobs per week. However, they can increase this number and acquire an additional job above their financial capacity by utilizing the option of borrowing money/taking a loan from the bank. This option was made available to each participant during actual bidding process. The program is set to ask the participant if they would like to borrow money once their capacity is full. Upon accepting the bank guarantee, a fee of $500 was deducted from the bidders account located on the "My Bids Info" page as shown in figure 6.

Notice

- Click the job number or current price of active bids to check the bid history of each jobs.
- Remember your initial job capacity is only 3. You cannot bid anymore if your capacity is over, without taking out a loan at $500 per site per contract.
- Reflesh your browser or click [ALL CURRENT BIDS] button frequently during the bid time to check updated current bid prices.
- * "Ept." means "Expected".
- Bids start on the 10, 30 and 50 minute times for **2106 jobs.** Bidding Time is 15 minutes.
- You have a clock, but remember your clock may be different to the server clock and you need to allow for this fact.
- The tab [MY BIDS INFO] can take 1:30 minutes to refresh. Be warned.

Currently your capacity is full including current winning bids and jobs in progress.
You cannot bid at this time.

If you ask for a Bank Guarantee, you can increase your capacity. Bank Guarantee fee is $500 per guarantee. Do you want? YES

Figure 6 Screen Capture of Bank Guarantee

Since this is a reverse auction process, protocols are established to ensure that only a lower value is accepted in the bidding process. If someone erroneously bids a higher value than the current bid value, the program displays the screen shot shown in figure 7 which warns that a bidder is entering a higher bid amount than the current lowest bid amount is not allowed.

Notice

- Click the job number or current price of active bids to check the bid history of each jobs.
- Remember your initial job capacity is only 3. You cannot bid anymore if your capacity is over, without taking out a loan at $500 per site per contract.
- Reflesh your browser or click [ALL CURRENT BIDS] button frequently during the bid time to check updated current bid prices.
- * "Ept." means "Expected".
- Bids start on the 10, 30 and 50 minute times for **2106 jobs.** Bidding Time is 15 minutes.
- You have a clock, but remember your clock may be different to the server clock and you need to allow for this fact.
- The tab [MY BIDS INFO] can take 1:30 minutes to refresh. Be warned.

Your bid amount is higher than current lowest bid amount!!

Don't forget this is a reverse auction !!!!

Check the current bid amount and try again!!!

Figure 7 Screen Capture of Higher Bid

At the end of the active bidding period, which was established as 15 minutes, jobs were automatically assigned to the bidder with the lowest values for each job. This

information about the bids won by any particular bidder is displayed on his "My Bids Info" page under the "My Jobs in Progress" bar as shown on figure 8.

Driver Co.'s Reverse Auction Bidding - MY BIDS' INFORMATION [ALL CURRENT BIDS] [ALL COMPLETED JOBS] [MY BIDS INFO] [LOGOUT]

Now: Day 22 (Monday), Week: 4

My Active Bids

JOB#	LOCATION	CURRENT PRICE	CURRENT BIDDER	TIME REMAINING	MY LOWEST BID AMOUNT	OUTBID
14	Woodlands	$ 100000	Driver Co.	806 seconds.	$ 100000	
15	Kingwood	$ 100000	Driver Co.	806 seconds.	$ 100000	

My Jobs in Progress

JOB#	LOCATION	Bid Amount	Job Start Date	Delays	Construction days	Cost to Date
8	Gleanloch farms	$ 100000	Day 16	3 days	4 days	$ 8600
9	Kingwood	$ 100000	Day 16	3 days	4 days	$ 8740
10	Sugarland	$ 100000	Day 16	3 days	4 days	$ 9200
11	Gleanloch farms	$ 100000	Day 16	3 days	4 days	$ 8600

My Completed jobs

Job#	Site	Bid Date	Bid Amount	Cost	Profit	Start day	End day	Rainy days	Profit Rate
5	Woodlands	Day 8	$ 49999	$ 11325	$ 38674	Day 9	Day 15	Day 2	77.35%

My summary

- Current Spare Capacity For Additional Work : **2** [Your total capacity : 6 (Initial capacity : 3, Added capacity by bank guarantee : 3]
- Current Financial Condition : **$ 41034** (No money paid to initiate work, No money paid in middle of job)
  [= Capital money [$40000] + Profits from completed jobs - Costs of current jobs in progress - Bank Guarantee Fee($500/loan)]
  Current My Total Bank Guarantee Fee : $ 2500

Figure 8 Screen Capture of "My Bid Info" Page

As shown in figure 8, "My Bid info page" displays the bid and job information relevant to a particular bidder. Participants were able to have access to this page throughout this game process and they were encouraged to visit it frequently. This page contains job relevant information which helps the participant to ensure their job status. This page includes,

1. All active jobs that participant has won, under the category "My Jobs in Progress",
2. Jobs that participant is bidding, under the category "My active bids". All information under this tab came directly from "All Current Bids" page, so this

also provides the current status of the bidding game to show whether the participant had been outbid on a particular job.

3. List of all successfully completed jobs, under the category "My Completed Jobs".

Along with the above mentioned information, it also shows the financial state of the participant, which helps him in framing his future strategies such as how many jobs he could bid for, and if he is already lagging behind due to his uncompleted jobs, how much money he would have to borrow from bank and other financial institutions to bid for a job in the following week. This financial information is provided under the category "My Summary". The information is:

1. Current calculated cash assets
2. Capacity for additional works including jobs with bank guarantees
3. Cumulative loan charges till date

Current financial condition provides the working capital information to the participants. It is calculated by deducting costs of current jobs and bank loans from the profits of completed jobs.

The formula used is:

Current Financial Condition = Capital Money + Profits from Completed Jobs – Costs of current jobs in progress – Bank Guarantees

Where, Capital Money = $40,000 and Bank Guarantee = $ 500 / Loan

Driver Co.'s Reverse Auction Bidding - ALL COMPLETED JOBS [ALL CURRENT BIDS] [ALL COMPLETED JOBS] [MY BIDS INFO] [LOGOUT]

Now: Day 56 (Monday), Week: 11

My Completed jobs

Job#	Site	Bid Date	Bid Amount	Cost	Profit	Start day	End day	Rainy days	Profit Rate
1	Pecan Grove	Day 1	$ 50000	$ 10725	$ 39275	Day 2	Day 6	Day 0	78.55%
2	Gleanloch farms	Day 1	$ 50000	$ 10950	$ 39050	Day 2	Day 8	Day 2	78.10%
3	Pecan Grove	Day 1	$ 50000	$ 10725	$ 39275	Day 2	Day 6	Day 0	78.55%
4	Woodlands	Day 1	$ 50000	$ 11325	$ 38675	Day 2	Day 11	Day 5	77.35%
8	Gleanloch farms	Day 15	$ 50000	$ 10950	$ 39050	Day 16	Day 24	Day 4	78.10%
9	Kingwood	Day 15	$ 50000	$ 11200	$ 38800	Day 16	Day 24	Day 4	77.60%
10	Sugarland	Day 15	$ 50000	$ 11700	$ 38300	Day 16	Day 24	Day 4	76.60%
11	Gleanloch farms	Day 15	$ 50000	$ 10950	$ 39050	Day 16	Day 24	Day 4	78.10%
25	Sugarland	Day 42	$ 50000	$ 11700	$ 38300	Day 44	Day 51	Day 3	76.60%
26	Pecan Grove	Day 42	$ 50000	$ 10725	$ 39275	Day 44	Day 49	Day 1	78.55%
27	Sugarland	Day 42	$ 50000	$ 11700	$ 38300	Day 44	Day 51	Day 3	76.60%

Figure 9 Screen Capture of All Completed Jobs

The job historical information for the Reverse Auction Bidding process was provided under "My Completed Jobs" tab as shown in figure 9.

This information was utilized by participants to determine their progress and financial success or failure. This information was also utilized to plan and execute strategies that would help to gain additional jobs in future. It includes:

1. Bid date along with start day and end day
2. Job location, and bid cost
3. Profit and associated percentages
4. Rainy days and associated number of delays

CHAPTER IV

RESULTS

Background

This chapter presents the results and the analysis of the results for a Reverse Auction Bidding game. The game used the web based ASP at SQL Server 2005 program developed at Texas A&M University as part of an ongoing research program into RAB theory of practice.

A six participant Reverse Auction Bidding game was conducted at the College of Architecture of Texas A&M University. All six participants had given the Keirsey Temperament Sorter (KTS) Test prior to the RAB game. The KTS results showed that three of the bidders were Administrators and three of the bidders were Conservators personality types.

Panchal (2008) and Chouhan (2009) showed evidence of four different trends in bidding behavior during the period of the game play. These trends are *Learning Trend, Discovering Trend, Competitive Trend,* and *Profit Gain Trend.* They observed that these patterns of trend were different when bidders were new to Revere Auction Bidding as compared to experienced persons playing the game. Bidders were bidding at the lower prices when the game started. It is because they did not know how to play the game. But when they get used to the game, they started competing against each other to win the job (Machado, 2009). Personality types of six players are shown in table 6. Three players had previously taken part in a RAB game.

Table 6 Personality Types of All Six Participants

Type	Name
Administrator	Pliers Co.
Administrator	Rove Co.
Administrator	Concrete Co.
Conservators	Log Co.
Conservators	Copper Co.
Conservators	Driver Co.

Previous research suggested that participants having personality as "Administrator" performed better in the bidding. Previous research findings have provided a starting point for this research.

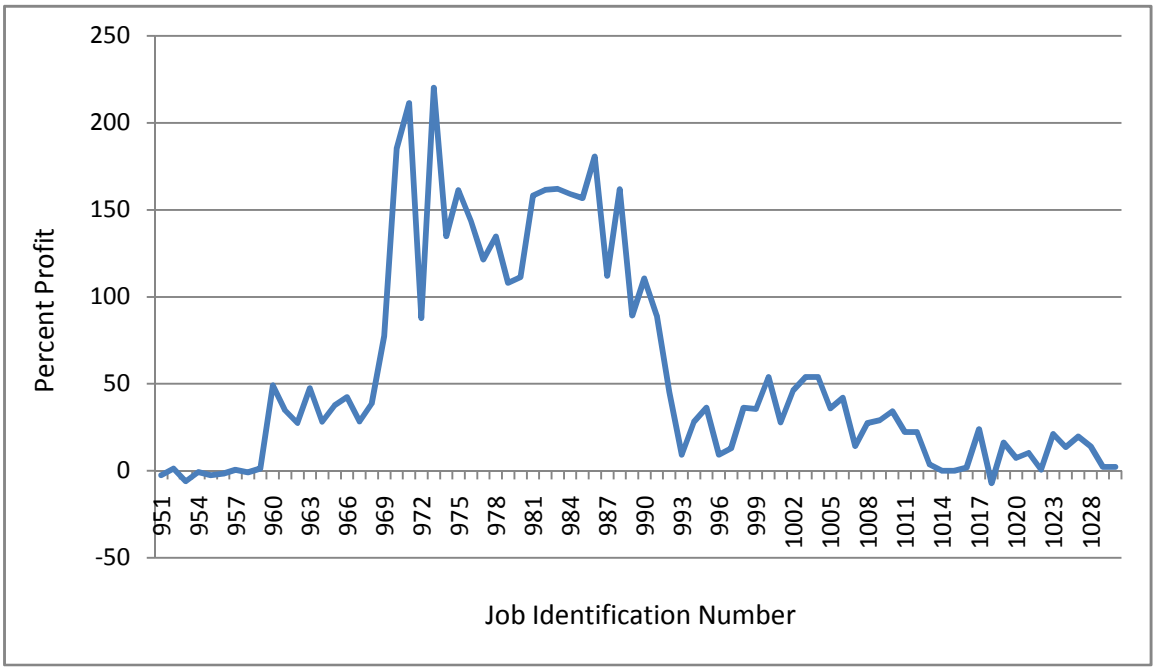

Figure 10 Bidders' Percentage Profit against Job Identification Number

A plot of the job number against the job profit is shown in figure 10. The game consisted of two research stages. Stage 1 consisted of normal bidding from job number 951 through job number 992, which is equivalent to six game weeks. Stage 2 consisted of the unethical period where Pliers Co. acted as a purchaser agent with the express objective of driving the price down. Stage 2 occurred from job number 993 to the end of the play. This study showed four different trends in bidding behavior as had been observed in previous researches:

1) Learning Trend:

   This trend was observed from Job Id 951 to 959. The bidding behavior through these jobs is called as "learning" trend. During this period, some participants were in the initial phase of learning the Reverse Auction Bidding game process. This trend covered the first week of bidding. In this trend, new participants tended to keep prices low.

2) Discovery Trend:

   The next trend was observed in week 2 which started with Job Id 960 through 968 which is termed as a "discovering" trend. An average rate of return for this period was 37 percent. During this period, most of the participants raised their initial bidding price and remaining players were observed to discover the game process of bidding at an upper limit.

3) Competitive Trend:

   This trend lasted from Job Id 969 to 992 which is termed as a "competitive" trend. An average rate of return for this period was 137 percent. By this point, all participants had fully understood the game process and they were competing with each other to obtain the job. The average rate at which participants outbid other participants increased at this stage. This period sees the start of the classic bidding strategy adopted by the better players.

4) Profit Gain Trend (Interference Period):

   The fourth trend started from week five with Job Id 993 and continued till the end of the bidding. The average rate of return for this period was 17.6 percent. At this stage all participants had reached a mature level of play in the game, although some were clearly better players than the others. Players are observed to develop their own strategies to maximize their individual profits. It was observed during this period that all bidders were not participating from the beginning and they started to reserve their bids until the last minute of bid closing. This period of play is different from the play behavior observed in first three weeks. This time bidders tended to wait for the best available opportunity to enter the game so as not to reveal their preferences and strategies. After Job Id 993, the owner's surrogate interfered in the bidding process. He deliberately tried

to bid at lower prices. In this way, owner could get the maximum benefit. At the end of fourth week, the profit gained for each job was much lower than it was observed till week three. Average profit gained in Week Three was 140 percent and that of Week Four was 22 percent. This fall in average profit shows owner's interference can affect the bidding behavior of participants. In addition, it is observed that bidders tended to wait for the best available opportunity to enter the game so as not to reveal their preferences and strategies.

Individual Bidder's Win Percentage

The winning percentage of each individual bidder was determined and shown in table 7. There were total 93 jobs available for reverse auction bidding and six bidders, Concrete Co., Copper Co., Driver Co., Log Co., Pliers Co., and Rove Co. participated.

Table 7 Percentage Jobs Won by Bidder

Contractor ID	Bids Won	Bids Won %
Concrete Co.	12	12.9
Copper Co.	10	10.7
Driver Co.	25	26.8
Log Co.	25	26.8
Pliers Co.	9	9.6
Rove Co.	12	12.9
Total Bids	93	100

Figure 11 shows the percentage of jobs won by each individual bidder.

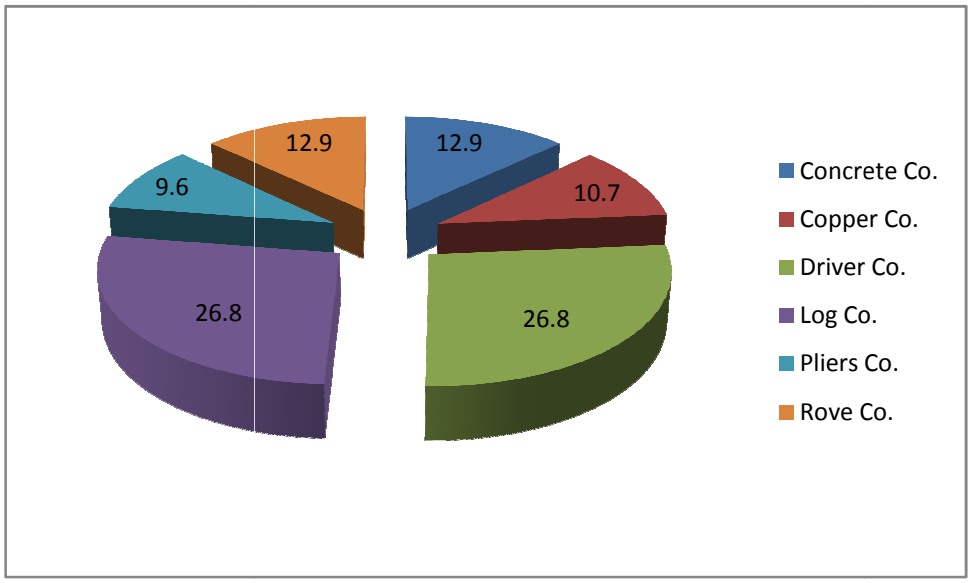

Figure 11 Percentage Win by Individual Bidder

A high rate of winning bids does not always translate into higher profits. As a comparison, winning one thousand of jobs at a single unit of profit is much worse than winning one job at a thousand of profit. The important thing is not just the job win rate, but the job win rate multiply by the job profit rate to yield a total return. Business success is measured by turnover of profit, not just turnover.

Further a combined analysis of all the bidders was done to find out percentage win by individual bidder. Figure shows that every bidder was successful in implementing his/her own strategies which provided them with considerable number of winning bids. Maximum number of bids are won by Log Co. and Driver Co. Further, Rove Co. and Concrete Co. won 12 bids each. Second lowest number of bids are won by Copper Co. Pliers Co. won the lowest number of bids. Since Pliers Co. was the owner's representative, its goal was not to win jobs but to lower down the profit margin of other

participants. In comparing the number of bids won by each individual and their personalities, it can be said that Guardians are better bidders than Rationals.

Comparison of Total Profit Earned by Individual Bidder to the Bidder's Personality

A comparison was made of bidder's personality against the total profit earned by each individual bidder to determine whether bidder personality has an impact on the level of return. The table 8 and figure 12 show the data for all the bidders with their average profit percentage and the total profit earned.

Table 8 Average Percent Profit and Total Profit

Contractor's Name	Contractor's Profit % Avg	Total Profit in $
Concrete Co.	63	119,395
Copper Co.	20	27,374
Driver Co.	28	96,862
Log Co.	36	126,982
Pliers Co.	98	121,779
Rove Co.	90	137,555

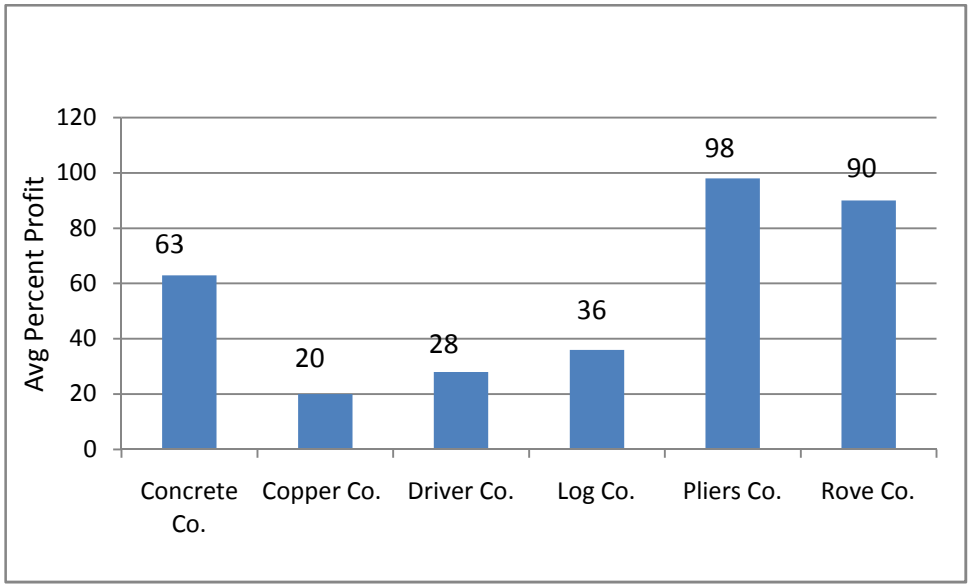

Figure 12 Average Profit Percentages per Job Won by Each Individual Bidder

When this profit analysis was compared to the bidder's personality types, it was found that Rove Co. and Pliers Co. having a temperament of a *Guardian* with a role of *Administrator* were successful in gaining maximum average profit per job compared to other bidders. Concrete Co. which has a temperament of Guardian with a role of Inspector managed to get average profit just above the average profit of all the bidders. While Copper Co., and Log Co. having a temperament of *Guardian* with a role of Protector failed to obtain an average profit that was above the average profit of all the bidders. In conclusion, the companies which have a role of Administrator and variant role as Supervisor are the most successful in the bidding process whereas the company that has a role of Conservator and variant role as Protector has a lower average profit.

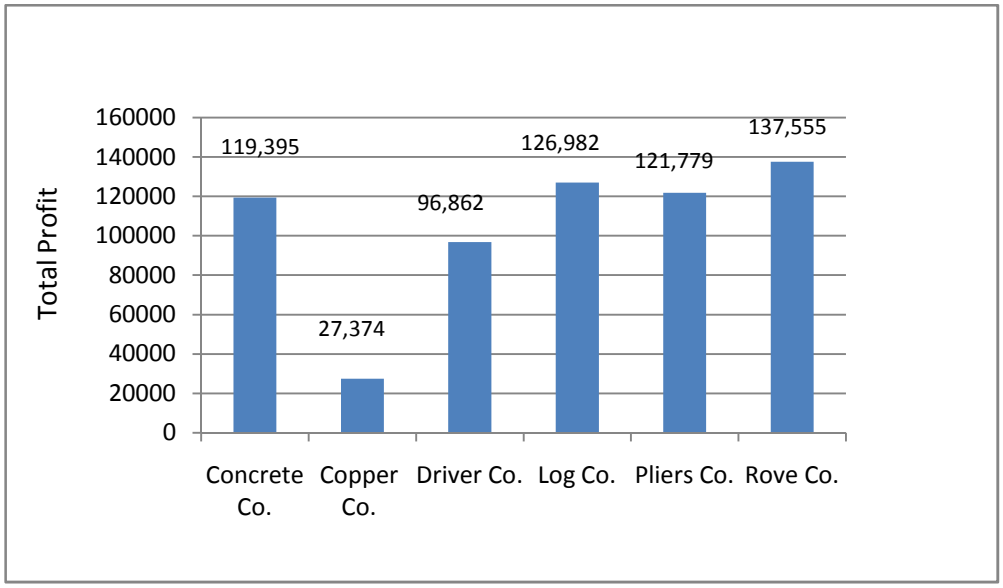

Figure 13 Total Profit Earned by Each Individual Bidder

Figure 13 shows the total profit for each participant. The average of total profits earned by all bidders was $104,991. The total profit earned by Rove Co. is five times higher than the total profit earned by Copper Co. Rove Co., Pliers Co., and Log Co. are called "economically effective" bidders as they earned the highest profits. Concrete Co., Driver Co., and Copper Co. have earned a profit lower than average total profit. These three bidders are called "economically ineffective" bidders, although Concrete Co. is close to upper three, but its average profit was slightly lower.

By comparing the total profits earned by individual with their personality types, it is confirmed that Administrators generally make higher profit in reverse auction when compared to Conservators.

Comparison of Individual Bidder's Personality Based on Loan Taken

The graph shown below displays the loan amount taken by individual bidder in the whole reverse auction bidding process. Every bidder had equal opportunity to utilize banker's guarantee by taking loan to increase bidder's capacity of handling jobs. However, some bidders made optimum use of it while some bidders hardly used it. This

was because, every time when they took bank loan, they had to pay $500 as a bank guarantee which was bit risky.

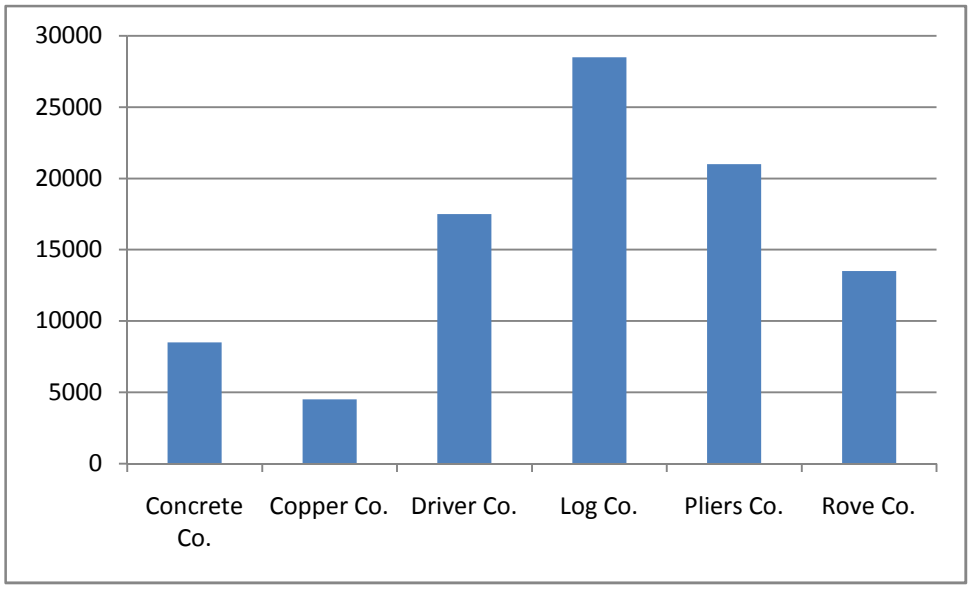

Figure 14 Loans Taken by Each Individual Bidder

Figure 14 shows the loan taken by each bidder. In comparing the graph of loans taken with total profit earned graph, it appears that companies that have taken higher loan amount have won more jobs. In addition, it is observed that except for Driver Co., total profit earned by each company increased with total loan amount. The conclusion is that Guardians with a role of Administrator included some risk factor in their strategies to win more jobs and earn higher levels of profit.

Analysis of an Individual Bidder

Next step was to analyze each individual bidder to study their bidding trend and analyze them. The objective was to identify any change in their bidding strategy over the nine week game duration. Specifically it was evaluated whether there was any significant change in the bidding pattern from start till the end of the bidding process for each participant.

Table 9 shows Concrete Co.'s bidding data for the game.

Table 9 Concrete Company's Bidding Data

bidID	jobID	Construction Cost in $	Bid Amount in $	Contractor's Profit in $	Cumulative Profit in $	% Contractor's Profit	% Average Contractor's Profit
2280	952	11701	11850	149	149	1.3	62.9
2281	959	12835	12989	154	303	1.2	
2488	970	14725	41999	27274	27577	185.2	
2570	983	18316	47999	29683	57260	162.1	
2581	985	18316	46999	28683	85943	156.6	
2582	987	13213	27999	14786	100729	111.9	
2925	1000	11701	18000	6299	107028	53.8	
2928	1001	14725	18800	4075	111103	27.7	
2919	1005	14725	19999	5274	116377	35.8	
3693	1033	12365	12000	-365	116012	-3.0	
3652	1035	13762	14000	238	116250	1.7	
3691	1043	14855	18000	3145	119395	21.2	
Total Profit Earned by Concrete Co.				119395			

Figure 15 shows the profit percentage for Concrete Company over the game period.

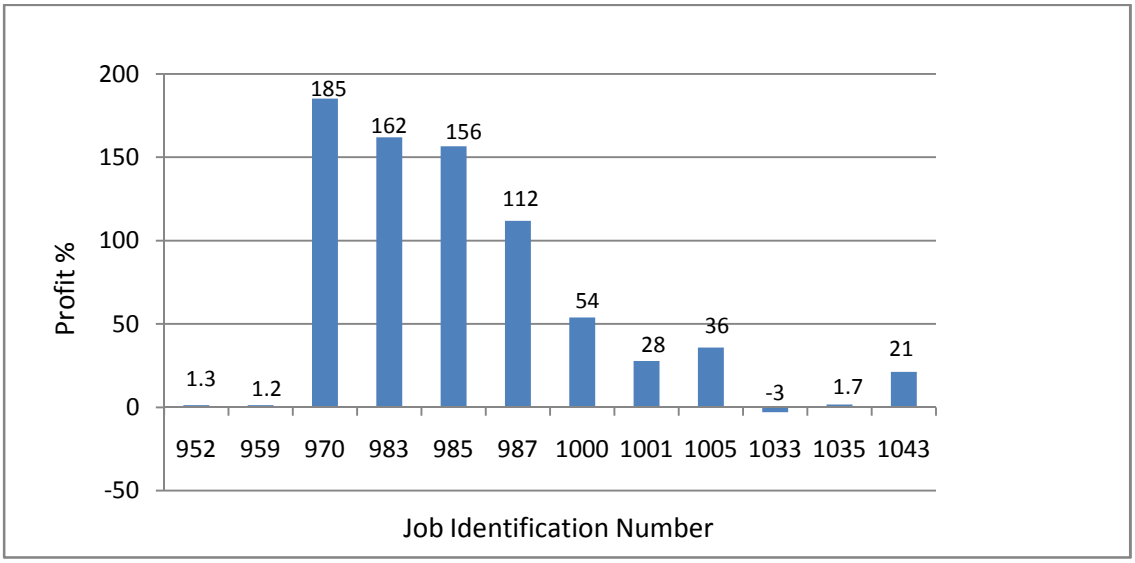

Figure 15 Concrete Company's Profit Percentage History

During the learning phase, Concrete Co. did not obtain a high profit level. But, from the Competitive phase, Concrete Co. started to gain relatively higher profit levels. During this phase, company won the jobs with 185 percent, 162 percent, 156 percent, and 112 percent profit margins. Concrete Company saw a slight fall in their profit margin when the owner's surrogate interfered in the bidding process. This result implies that the owner's interference had a negative impact on bidder's bidding strategy. The average profit at which revenues are generated for Concrete Company is 62.9 percent per job while total profit gained was $119,395.

Table 10 Copper Company's Bidding Data

bidID	jobID	Construction Cost in $	Bid Amount in $	Contractor's Profit in $	Cumulative Profit in $	% Contractor's Profit	Average Contractor's Profit %
2262	957	14914	14985	71	71	0.5	19.6
2431	965	14914	20500	5586	5657	37.5	
2421	966	13213	18800	5587	11244	42.3	
2667	994	11701	14999	3298	14542	28.2	
2653	997	13213	14900	1687	16229	12.8	
2924	1006	14725	20900	6175	22404	41.9	
2927	1007	18316	20900	2584	24988	14.1	
3169	1021	11701	12900	1199	26187	10.2	
3168	1022	12835	12900	65	26252	0.5	
3500	1027	13865	14987	1122	27374	8.1	
Total Profit Earned by Copper Co.				27374			

Figure 16 shows the profit percentage for Copper Company over the game period.

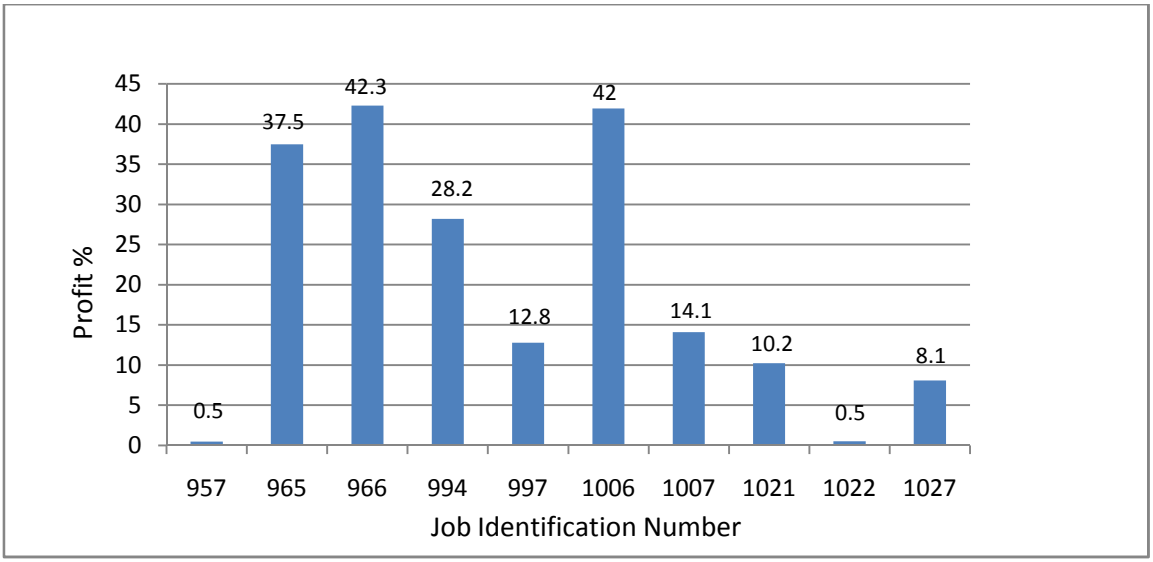

Figure 16 Copper Company's Profit Percentage History

Copper Co. only got one job with $71 profit margin during the learning stage as shown in table 10. During the first week, Copper Co. did well when they gained a 0.5% total

profit which was an above average profit for the whole group. In the competitive stage, Copper Co. had already formulated its own strategies that could equip them to win more jobs with larger profit margins. But in the final stage, the owner's interference clearly made some adverse effects on the performance of Copper Co. in winning more jobs. This was caused by Copper Co.'s minimal loan borrowed from the bank that affected the increase of its job capacity. Copper Co.'s average revenue for every job was at 19.6% and the total profit was at $27,374.

Table 11 Driver Company's Bidding Data

bidID	jobID	Construction Cost in $	Bid Amount in $	Contractor Profit in $	Cumulative profit in $	% Contractor's Profit	Avg Contractor's Profit %
2385	962	14914	18998	4084	4084	27.4	
2428	964	11701	15000	3299	7383	28.2	
2576	982	14914	39000	24086	31469	161.5	
2584	990	14725	31000	16275	47744	110.5	
2656	992	11701	17000	5299	53043	45.3	
2671	993	18316	20000	1684	54727	9.2	
2672	995	13213	17999	4786	59513	36.2	
2668	996	18316	19994	1678	61191	9.2	
2914	1003	11701	18000	6299	67490	53.8	
2910	1004	11701	18000	6299	73789	53.8	
2922	1008	14914	19000	4086	77875	27.4	
2896	1011	14725	18000	3275	81150	22.2	27.7
2899	1012	14725	18000	3275	84425	22.2	
3178	1013	18316	19000	684	85109	3.7	
3182	1014	18316	18316	0	85109	0.0	
3185	1015	14725	14725	0	85109	0.0	
3188	1016	14725	15000	275	85384	1.9	
3116	1018	18316	17000	-1316	84068	-7.2	
3488	1024	13213	15000	1787	85855	13.5	
3496	1028	14914	17000	2086	87941	14.0	
3459	1029	14955	16500	1545	89486	10.3	
3501	1030	13213	13500	287	89773	2.2	
3676	1034	14575	18499	3924	93697	26.9	

Table 11 Continued

bidID	jobID	Construction Cost in $	Bid Amount in $	Contractor Profit in $	Cumulative profit in $	% Contractor's Profit	Average Contractor's Profit %
3690	1038	13754	12985	-769	92928	-5.6	
3681	1042	14955	18889	3934	96862	26.3	
Total Profit Earned by Driver Co.				96862			

Figure 17 shows the profit percentage for Driver Company over the game period.

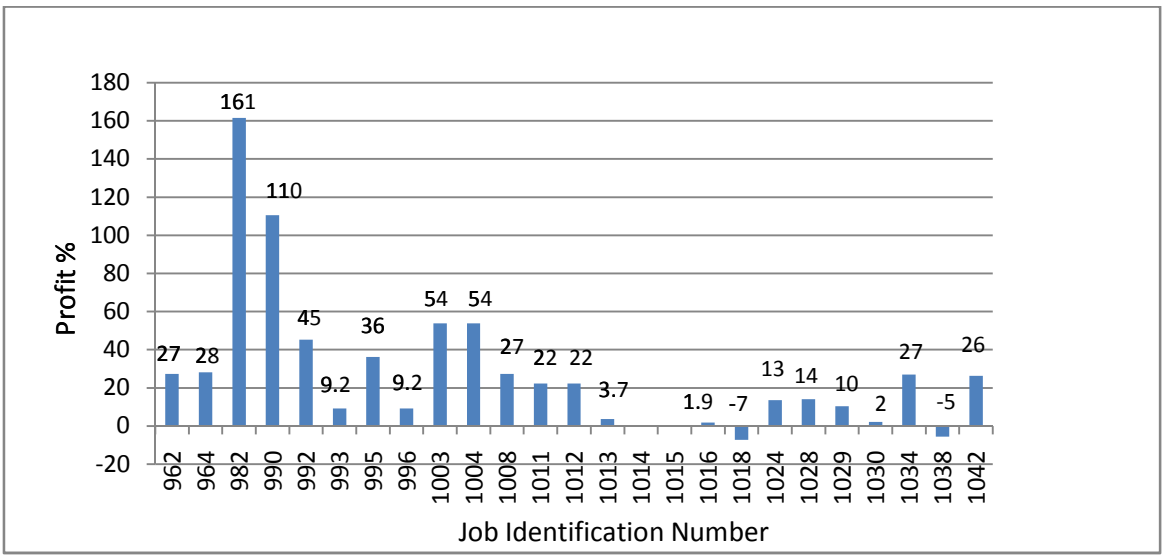

Figure 17 Driver Company's Profit Percentage History

Driver Co. had engaged in Reverse Auction Bidding process before. Since Driver Company was competing with relatively new bidders for this bidding, it was able to obtain 27% and 28% of profit for the first two jobs it won as shown in table 11. However, in the competitive phase, things started to change when the new bidders were gradually getting acquainted with the bidding process. But this did not hinder Diver Co. from earning a 161% and 110% profit for just wining a few number of jobs. At the latter part of the bidding, Diver Co. decided to focus on getting more jobs regardless of profit

margin. Being an experienced bidder, Diver Co. was still influenced by the owner as seen on Job Id 1008 to 1042. By the initial phase, Diver Co. was already out of money and had no job capacity. But the moment the company acquired some loans and made an effort to increase its job capacity, it was able to obtain higher profit margin. Despite this, the revenue of Diver Co. was just at 27.7% per job which is below the total average of all the bidders and the profit was at $96,862 which is not considered to be a significant amount compared to other bidder's profits.

Table 12 Log Company's Bidding Data

bidID	jobID	Construction Cost in $	Bid Amount in $	Contractor's Profit in $	Cumulative profit in $	% Contractor's Profit	Average Contractor's Profit %
2213	951	12835	12500	-335	-335	-2.6	36
2273	954	14914	14800	-114	-449	-0.8	
2209	955	12835	12500	-335	-784	-2.6	
2274	956	13213	12990	-223	-1007	-1.7	
2275	958	13213	13100	-113	-1120	-0.9	
2429	961	12835	17300	4465	3345	34.8	
2409	963	12835	18920	6085	9430	47.4	
2391	967	18316	23488	5172	14602	28.2	
2432	968	14725	20400	5675	20277	38.5	
2491	975	14914	38950	24036	44313	161.2	
2578	981	14725	38000	23275	67588	158.1	
2583	986	12835	36000	23165	90753	180.5	
2666	998	13213	18000	4787	95540	36.2	
2918	999	13213	17900	4687	100227	35.5	
2926	1002	13213	19300	6087	106314	46.1	
2912	1009	14725	18999	4274	110588	29.0	
2884	1010	14914	19999	5085	115673	34.1	
3181	1020	14914	15999	1085	116758	7.3	
3470	1023	13213	15998	2785	119543	21.1	
3486	1031	13213	13500	287	119830	2.2	
3620	1032	14656	18999	4343	124173	29.6	
3665	1037	13213	13589	376	124549	2.8	
3684	1039	13865	12998	-867	123682	-6.3	
3692	1040	14725	18750	4025	127707	27.3	

Table 12 Continued

bidID	jobID	Construction Cost in $	Bid Amount in $	Contractor's Profit in $	Cumulative profit in $	% Contractor's Profit	Average Contractor's Profit %
3687	1041	14725	14000	-725	126982	-4.9	
Total Profit Earned by Log Co.				126982			

Figure 18 shows the profit percentage for Log Company over the game period.

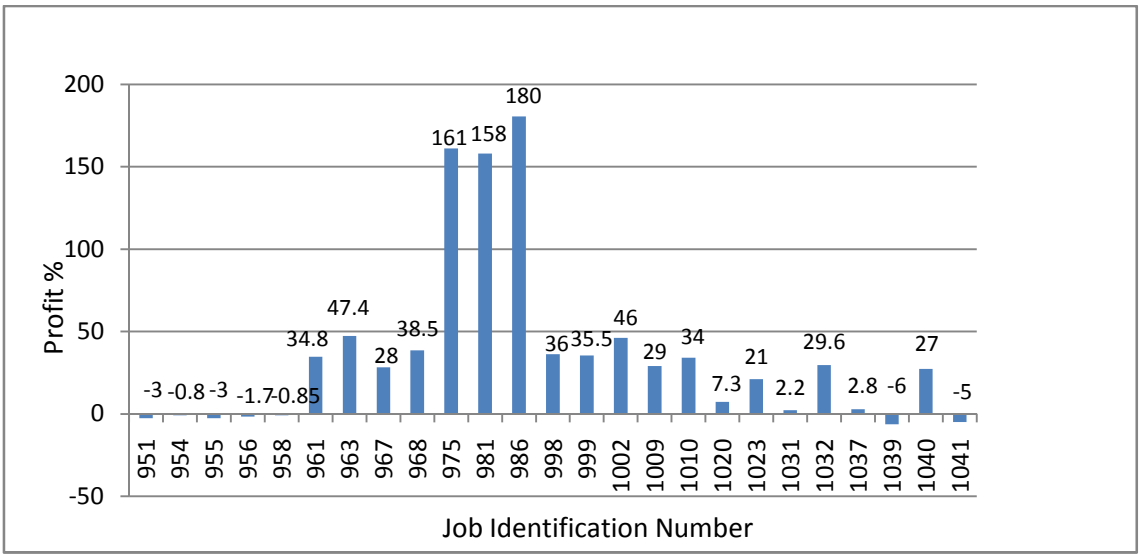

Figure 18 Log Company's Profit Percentage History

Log Co. started to win projects in the learning stage but in spite of this, company was still experiencing losses. At first, Log Co. was not knowledgeable on how to place bids for jobs. As a result, it made the lowest bids during the starting phase of the game in order to win jobs without considering obtaining higher profits. By the time Log Co. was learning about the process during the competitive stage, it acquired 161%, 158% and 180% profit margin as shown in table 12. This was the turning point for the Log Company. Log Company's primary goal was to gain the maximum number of jobs and

they became successful in achieving this with 25 jobs won which is 27% of the total jobs. To supplement this, Log Co. availed loans during the bidding process. But when the owner interfered, the profit margin declined significantly. Because of the impact of the owner's interference, Log Co. was only able to get jobs but no profits for the last stage of the bidding process. The revenue of Log Co. was at 36% per job and a profit of $126,982 which is the second to the highest profit generated among all the bidders.

Table 13 Pliers Company's Bidding Data

bidID	jobID	Construction Cost in $	Bid Amount in $	Contractor's Profit in $	Cumulative profit in $	% Contractor's Profit	Average Contractor's Profit %
2482	972	14914	28000	13086	13086	87.7	98.1
2489	976	11701	28500	16799	29885	143.6	
2472	977	14914	33000	18086	47971	121.3	
2503	978	13213	31000	17787	65758	134.6	
2497	979	14914	31000	16086	81844	107.9	
2493	980	14914	31500	16586	98430	111.2	
2572	989	13213	25000	11787	110217	89.2	
2567	991	13213	25000	11787	122004	89.2	
3499	1026	14725	14500	-225	121779	-1.5	
Total Profit Earned by Pliers Co.				121779			

Figure 19 shows the profit percentage for Pliers Company over the game period.

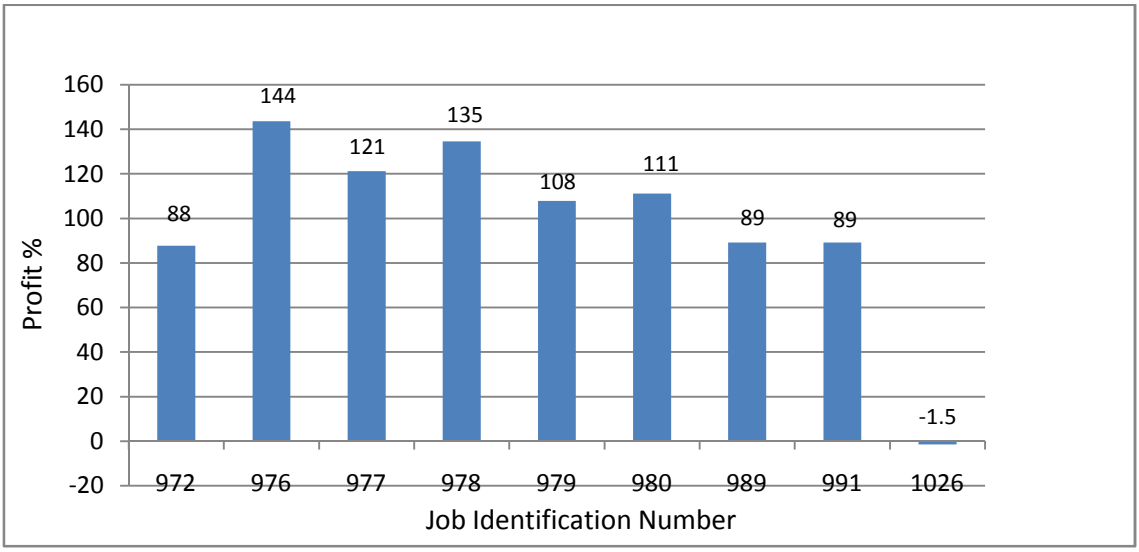

Figure 19 Profit Percentage History of Pliers Company

Pliers Co. was a representative of its owner throughout the bidding process. Its goal was to reduce the profit margin of the participants instead of winning bids so that owner can obtain maximum benefits. From week one to week three, Pliers Co. acted like a normal bidder. Pliers Company bid for the jobs and won some of the jobs those were available in the first three weeks of the bidding game as it can be seen from table 13. By week four, the owner's surrogate interfered in the bidding process. Owner's surrogate started to bid in lower values to decrease the profit margin. This strategy created a negative impact on the participants. So, they tried to counter the bids of Pliers Co. by bidding lower than Pliers Co.'s bids. Therefore, it can be concluded that Pliers Co. was able to successfully achieve their primary objective. During the last stage of the game, the profit margin was significantly reduced to the point that other bidders tried to win as many jobs as possible without considering the profit which yielded losses from some jobs.

Table 14 Rove Company's Bidding Data

bidID	jobID	Construction Cost in $	Bid Amount in $	Contractor's Profit in $	Cumulative Profit in $	% Contractor's Profit	Average Contractor's Profit %
2277	953	11701	11000	-701	-701	-6.0	89.4
2430	960	11701	17452	5751	5050	49.1	
2495	969	18316	32499	14183	19233	77.4	
2498	971	11701	36422	24721	43954	211.3	
2502	973	11701	37452	25751	69705	220.1	
2438	974	14914	35000	20086	89791	134.7	
2579	984	11701	30299	18598	108389	158.9	
2553	988	13213	34599	21386	129775	161.9	
3183	1017	11701	14499	2798	132573	23.9	
3187	1019	11701	13599	1898	134471	16.2	
3495	1025	11701	13999	2298	136769	19.6	
3654	1036	13213	13999	786	137555	5.9	
Total Profit Earned by Rove Co.				137555			

Figure 20 shows the profit percentage for Rove Company over the game period.

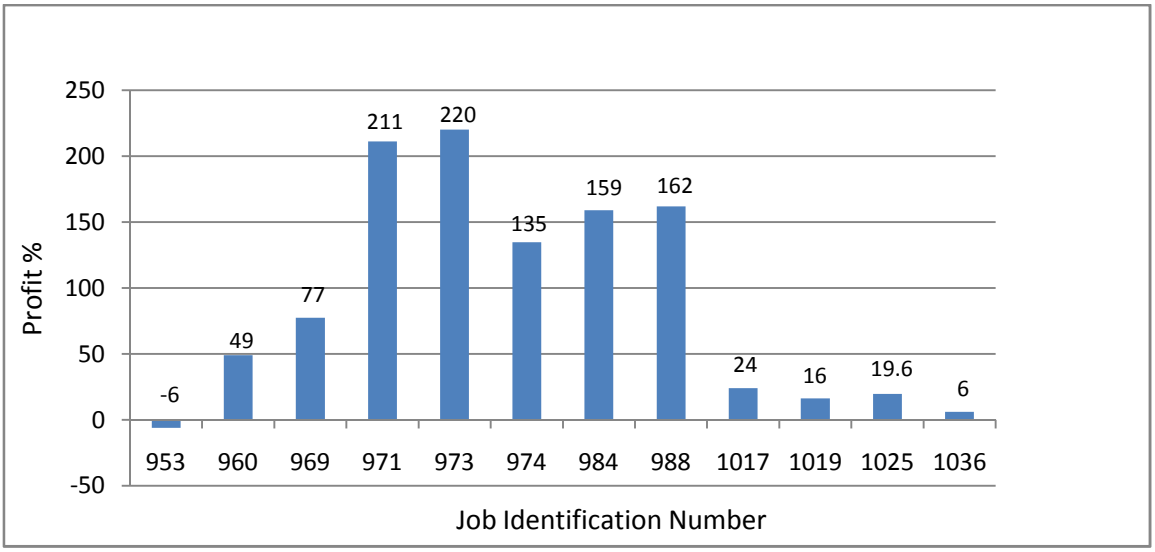

Figure 20 Profit Percentage History of Rove Company

Rove Co. was one of the experienced participants in the game. Since its competitors were newcomers, it had to lose first to win the job for week one. By the middle stage of the bidding, it already yielded 211% and 220% of profit margin as it can be seen from table 14. It was able to make revenues of 89% per job which was above average and a total profit of $137,555 which was the highest generated profit among all bidders. In order to do this, Rove Co. acquired loans from the bank to improve its job capacity and to win 12 jobs. However, Rove Co. also experienced some losses when the owner interfered during the last stage of the bidding.

Figure 21 shows the cumulative total profit for each bidder.

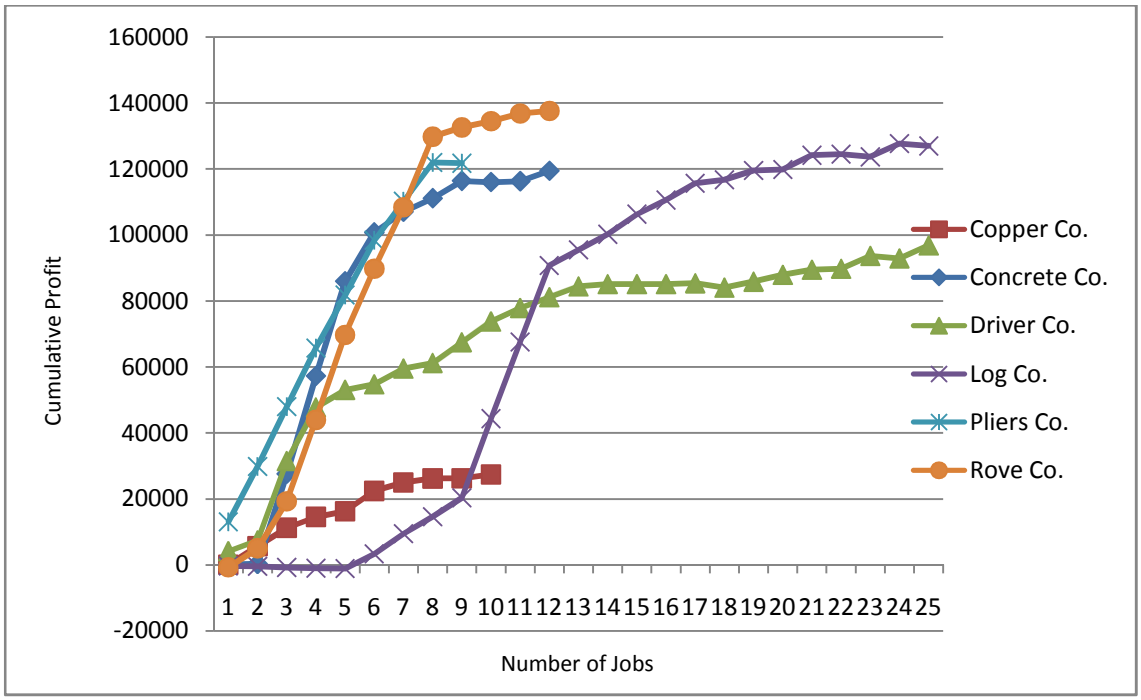

Figure 21 Cumulative Total Profit of Each Bidder

Amongst the bidders, Rove Company was relatively consistent throughout. This company used only one strategy through the game. The inconsistent player was Log Company. Log Company changed its strategy from time to time to win the maximum number of jobs and was successful, but it earned less profit per job.

Table 15 shows jobs available per week and their distribution of winning bids.

Table 15 Jobs Available and Jobs Won by Each Individual Bidder

Week	Available Jobs per week	Jobs won					
		Concrete Co.	Copper Co.	Driver Co.	Log Co.	Pliers Co.	Rove Co.
1	9	2	1	0	5	0	1
2	9	0	2	2	4	0	1
3	12	1	0	0	1	6	4
4	11	3	0	2	2	2	2
5	7	0	2	4	1	0	0
6	14	3	2	5	4	0	0
7	10	0	2	5	1	0	2
8	9	0	1	4	2	1	1
9	12	3	0	3	5	0	1
TOTAL JOBS	93	12	10	25	25	9	12

The critical observation on the bidding strategy is:

Pliers Company who was owner's surrogate started interfering from fourth week. Since its job was to lower the bidding amount of other bidders, it did not try to win jobs from fourth week as it can be seen from above table. The owner's surrogate is the most successful if it wins almost no jobs, but drives the prices down to a point where the other companies outbid the surrogate. Log Company won at least one job in each week.

Table 16 shows the number of bids and the individual distribution of bidder who made those bids on weekly basis.

Table 16 Total and Individual Number of Bids Made by Bidder per Week

Week	Total Bids per week	Bids made per week by					
		Concrete Co.	Copper Co.	Driver Co.	Log Co.	Pliers Co.	Rove Co.
1	123	15	27	12	33	12	24
2	151	26	42	14	30	18	21
3	71	12	4	7	11	11	26
4	81	12	7	14	11	11	26
5	88	9	19	16	22	20	2
6	256	33	17	47	64	31	64
7	260	19	33	32	59	59	58
8	313	36	51	33	83	63	47
9	192	39	16	13	61	39	24
TOTAL BIDS	1535	201	216	188	374	264	292

It is clear that the number of bids per job increased significantly when the owner's surrogate started interfering in the bidding process. In the eighth week, bidders were competing with each other so much that the total bid number for this week reached 313, which is the highest number in any of the weeks. The bids dropped in the last week may indicate a frustration with either the game or the interference. The owner's surrogate indicated after the research game that there were significant amount of highly negative comments about the surrogate's behavior. Due to the confidentiality of the bid system, the other bidders did not know who the surrogate was, nor were they aware of the deliberate attempt at unethical behavior.

Figure 22 shows the number of jobs available per week and the number of bids per week.

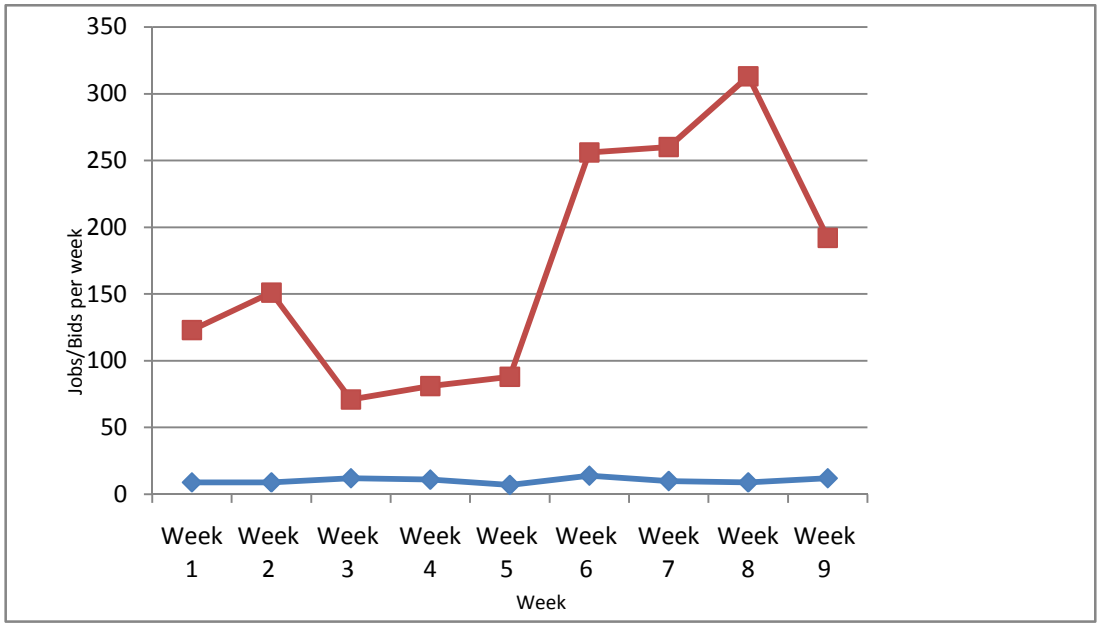

Figure 22 Jobs/Bids per Week vs Week

Table 17 shows the success rate of each bidder.

Table 17 Success Rate of Individual Bidder per Week

Week	Success rate of bidders (Jobs won v/s Jobs available)						
	Concrete Co.	Copper Co.	Driver Co.	Log Co.	Pliers Co.	Rove Co.	Total Jobs %
1	22	11	0	56	0	11	100
2	0	22	22	44	0	11	100
3	8	0	0	8	50	33	100
4	27	0	18	18	18	18	100
5	0	29	57	14	0	0	100
6	21	14	36	29	0	0	100
7	0	20	50	10	0	20	100
8	0	11	44	22	11	11	100
9	25	0	25	42	0	8	100
Summation of Percentage	104	107	253	243	79	113	900

The success rate was calculated by dividing the total jobs won by the bidder to the total jobs available in that respective week. Further, success rate of each bidder was calculated by totaling the success rate of each week.

Table 18 shows bidders' bidding rate per week.

Table 18 Bidders' Bidding Rate per week

Week	Bidders' Bidding Rate per Week						
	Concrete Co.	Copper Co.	Driver Co.	Log Co.	Pliers Co.	Rove Co.	Total Bids
1	12	22	10	27	10	20	100
2	17	28	9	20	12	14	100
3	17	6	10	15	15	37	100
4	15	9	17	14	14	32	100
5	10	22	18	25	23	2	100
6	13	7	18	25	12	25	100
7	7	13	12	23	23	22	100
8	12	16	11	27	20	15	100
9	20	8	7	32	20	13	100
TOTAL BIDS	123	130	112	207	149	179	900

Above table shows the individual bidders bidding rate per week. The bidder's rate was calculated by dividing the number of times the bidder bided for different jobs in a week to total number of bids in that respective week. Further the sum of all the bidding rates per week was calculated to find out whether bidder adopted aggressive way or strategic way to win jobs.

It was observed that Log Co. was the most aggressive among all the bidders. Rove Co. and Pliers Co. were of average aggression. While comparing the above data with the personalities, it was observed that Guardians with a role of Conservators and variant role as Protectors were more aggressive in bidding than Administrators with a variant role as Supervisors. Although, Guardian with a variant role as Inspector which was Concrete Co. showed less than average aggression but played strategically.

To sum up, it can be said that the bidders who bid aggressively are the ones who won most of the jobs as compared to those who prefer biding strategically. Personalities who made higher profits in reverse auction bidding are also the aggressive bidders as well as the personalities with lower profits are the ones who preferred strategic bidding rather than aggressive bidding. So logically speaking, bidding mainly depends on the bidder's rate of aggression in bidding.

Table 19 shows the ratio of the success rate to the bid rates.

Table 19 Ratio of Success Rate to Bidding Rate

Ratio of Success Rate to Bidding Rate							
	Concrete Co.	Copper Co.	Driver Co.	Log Co.	Pliers Co.	Rove Co.	Total Week %
Success Rate	104	107	253	243	79	113	900
Bidding Rate	123	130	112	207	149	179	900
Ratio	0.8455284	0.823076	2.25892	1.1739	0.5302	0.6312	1

This table is a different representation of the data. The success rate has been normalized to 100 for each week. This ratio can be used at an early stage to detect poor bidding practice and good bidding practice.

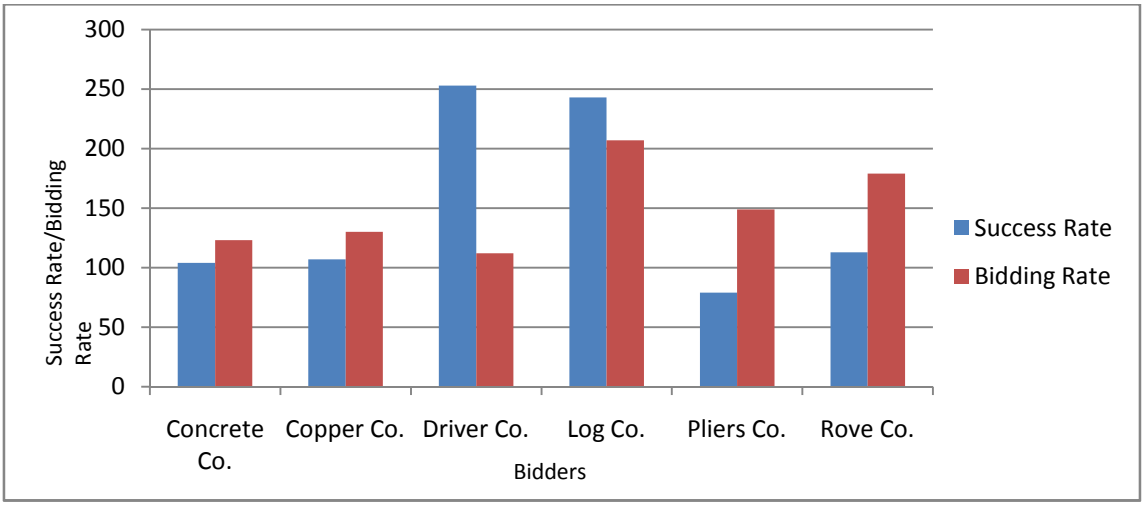

Figure 23 Success Rate and Bidding Rate of Each Individual Company

After comparing success rate with bidding rate of each bidder, it was observed that Driver Co. and Log Co. with a temperament of Guardian and role of Conservator showed less aggression than the jobs they won. Pliers Company, who was an owner's representative, was least successful in winning jobs. The summery of success rate and their respective personalities is as follows:

CHAPTER V
CONCLUSION

The study of Reverse Auction Bidding has been undertaken at Texas A&M University since 2004, starting with the Robert Van Vleet. This research has progressed to a stage of considering the impact of bidder's personality on the outcome of the Reverse Auction Bidding game. The research on Reverse Auction Bidding previously has shown that a gain obtained over seven weeks passes through a series of stages. This current research showed evidence of the traditional stages of play which are learning, discovering, competitive, and profit gain phases.

This research looked at two specific problems. The first problem was whether bidder's personality had an impact on the relative returns. Bidder's personality was measured using the Keirsey Temperament Sorter Test. The results show that bidder's personality type is a strong indicator of total returns. A personality type of Administrators generally performs better. These findings contain the observations made by previous researchers.

The second stage of this research related to owner's interference in the game play. The game was allowed to develop normally for three weeks, after that time an owner's surrogate interfered with the reverse auction. The results showed a drop in average profit after the start of the interference.

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APPENDIX A

KEIRSEY TEMPERAMENT SORTER TEST

The Keirsey Temperament Sorter

For each question, decide on answer a or b and put a check mark in the proper column of the answer sheet. Scoring directions are provided. There is no right or wrong answers since about half the population agrees with whatever answer you choose.

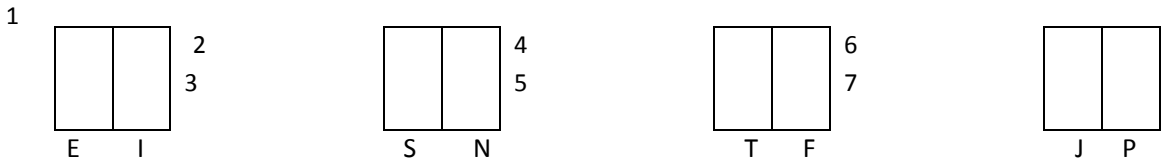
1. When the phone rings do you
   a. hurry to get to it first
   b. hope someone will answer
2. Are you more
   a. observant than introspective
   b. introspective than observant
3. Is it worse to
   a. have your head in the clouds
   b. be in a rut
4. With people are you usually more
   a. firm than gentle
   b. gentle than firm
5. Are you more comfortable in making
   a. critical judgments
   b. value judgments
6. Is clutter in the workplace something you
   a. take time to straighten up
   b. tolerate pretty well
7. Is it your way to
   a. make up your mind quickly
   b. pick an choose at some length
8. Waiting in line, do you often
   a. chat with others
   b. b. stick to business
9. Are you more
   a. sensible than ideational
   b. ideational than sensible
10. Are you more interested in
    a. what is actual
    b. what is possible
11. In making up your mind are you more likely
    a. to go by data
    b. to go by desires
12. In sizing up others do you tend to be
    a. objective and impersonal
    b. friendly and personal
13. Do you prefer contracts to be
    a. signed, sealed, and delivered
    b. settled on a handshake
14. Are you more satisfied having
    a. a finished product
    b. work in progress
15. At a party, do you
    a. interact with many, even strangers
    b. interact with a few friends
16. Do you tend to be more
    a. factual than speculative
    b. speculative than factual
17. Do you like writers who
    a. say what they mean
    b. use metaphors and symbolism
18. Which appeals to you more:
    a. consistency of thought
    b. harmonious relationships
19. If you must disappoint someone are you
    a. usually frank and straightforward
    b. warm and considerate
20. On the job do you want your activities

a. scheduled
b. unscheduled

21. Do you more often prefer
    a. final, unalterable statements
    b. tentative, preliminary statements
22. Does interacting with strangers
    a. energize you
    b. tax your reserves
23. Facts
    a. speak for themselves
    b. illustrate principles
24. Do you find visionaries and theorists
    a. somewhat annoying
    b. rather fascinating
25. In a heated discussion, do you
    a. stick to your guns
    b. look for common ground
26. Is it better to be
    a. Just
    b. merciful
27. At work, is it more natural for you to
    a. point out mistakes
    b. try to please others
28. Are you more comfortable
    a. after a decision
    b. before a decision
29. Do you tend to
    a. say right out what's on your mind
    b. keep your ears open
30. Common sense is
    a. usually reliable
    b. frequently questionable
31. Children often do not
    a. make themselves useful enough
    b. exercise their fantasy enough
32. When in charge of others do you tend to be
    a. firm and unbending
    b. forgiving and lenient
33. Are you more often
    a. a cool-headed person
    b. a warm-hearted person
34. Are you prone to
    a. nailing things down
    b. exploring the possibilities
35. In most situations are you more
    a. deliberate than spontaneous
    b. spontaneous than deliberate
36. Do you think of yourself as
    a. an outgoing person
    b. a private person
37. Are you more frequently
    a. a practical sort of person
    b. a fanciful sort of person
38. Do you speak more in
    a. particulars than generalities
    b. generalities than particular
39. Which is more of a compliment:
    a. "There's a logical person"
    b. "There's a sentimental person"
40. Which rules you more
    a. your thoughts
    b. your feelings
41. When finishing a job, do you like to
    a. tie up all the loose ends
    b. move on to something else
42. Do you prefer to work
    a. to deadlines
    b. just whenever
43. Are you the kind of person who
    a. is rather talkative
    b. doesn't miss much
44. Are you inclined to take what is said
    a. more literally
    b. more figuratively
45. Do you more often see
    a. what's right in front of you
    b. what can only be imagined
46. Is it worse to be
    a. softy
    b. hard-nosed
47. In trying circumstances are you sometimes
    a. too unsympathetic

b. too sympathetic
48. Do you tend to choose
    a. rather carefully
    b. somewhat impulsively
49. Are you inclined to be more
    a. hurried than leisurely
    b. leisurely than hurried
50. At work do you tend to
    a. be sociable with your colleagues
    b. keep more to yourself
51. Are you more likely to trust
    a. your experiences
    b. your conceptions
52. Are you more inclined to feel
    a. down to earth
    b. somewhat removed
53. Do you think of yourself as a
    a. tough-minded person
    b. tender-hearted person
54. Do you value in yourself more that you are
    a. reasonable
    b. devoted
55. Do you usually want things
    a. settled and decided
    b. just penciled in
56. Would you say you are more
    a. serious and determined
    b. easy going
57. Do you consider yourself
    a. a good conversationalist
    b. a good listener
58. Do you prize in yourself
    a. a strong hold on reality
    b. a vivid imagination
59. Are you drawn more to
    a. fundamentals
    b. overtones
60. Which seems the greater fault
    a. to be too compassionate
    b. to be too dispassionate
61. Are you swayed more by
    a. convincing evidence
    b. a touching appeal
62. Do you feel better about
    a. coming to closure
    b. keeping your options open
63. Is it preferable mostly to
    a. make sure things are arranged
    b. just let things happen naturally
64. Are you inclined to be
    a. easy to approach
    b. somewhat reserved
65. In stories do you prefer
    a. action and adventure
    b. fantasy and heroism
66. Is it easier for you to
    a. put others to good use
    b. identify with others
67. Which do you wish more for yourself:
    a. strength of will
    b. strength of emotion
68. Do you see yourself as basically
    a. thick-skinned
    b. thin-skinned
69. Do you tend to notice
    a. disorderliness
    b. opportunities for change
70. Are you more
    a. routinized than whimsical
    b. whimsical than routinized

	a	b		a	b		a	b		a	b		a	b		a	b		a	b
1			2			3			4			5			6			7		
8			9			10			11			12			13			14		
15			16			17			18			19			20			21		
22			23			24			25			26			27			28		
29			30			31			32			33			34			35		
36			37			38			39			40			41			42		
43			44			45			46			47			48			49		
50			51			52			53			54			55			56		
57			58			59			60			61			62			63		
64			65			66			67			68			69			70		
1			2 3			4 3			4 5			6 5			6 7			8 7		



Directions for Scoring

1. **Add down** so that the total number of a answers is written in the box at the bottom of each column. Do the same for the b answers you have checked. Each of the 14 boxes should have a number it.
2. **Transfer the number** in box #1 of the answer grid to box #1 below the answer grid. Do this for box # 2 as well. Note, however, that you have two numbers for boxes 3 through 8. Bring down the first number for each box beneath the second, as indicated by the arrows. Now add all the pairs of numbers and enter the total in the boxes below the answer grid, so each box has only one number.
3. **Now you have** four pairs of numbers. Circle the letter below the larger numbers of each pair. If the two numbers of any pair are equal, then circle neither, but put a large X below them and circle it.

APPENDIX B

IRB – APPROVAL FORM

TEXAS A&M UNIVERSITY
DIVISION OF RESEARCH AND GRADUATE STUDIES - OFFICE OF RESEARCH COMPLIANCE

1186 TAMU, General Services Complex
College Station, TX 77843-1186
750 Agronomy Road, #3500

979.458.1467
FAX 979.862.3176
http://researchcompliance.tamu.edu

Human Subjects Protection Program — Institutional Review Board

DATE:	10-Sep-2009

MEMORANDUM

TO:	CHAUDHARI, SUSHIL VINAY 77843-3578
FROM:	Office of Research Compliance Institutional Review Board
SUBJECT:	Initial Review

Protocol Number:	2009-0561
Title:	Owner's Interference in Reverse Auction Bidding to Skew a Free Market
Review Category:	Expedited
Approval Period:	10-Sep-2009 **To** 09-Sep-2010

Approval determination was based on the following Code of Federal Regulations:

45 CFR 46.110(b)(1) - Some or all of the research appearing on the list and found by the reviewer(s) to involve no more than minimal risk.
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(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research

employing survey, interview, oral history, focus group, program evaluation, human factors evaluation or quality assurance methodologies.

(Note: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b) (3). This listing refers only to research that is not exempt.)

Provisions:

This research project has been approved for one (1) year. As principal investigator, you assume the following responsibilities

1. **Continuing Review:** The protocol must be renewed each year in order to continue with the research project. A Continuing Review along with required documents must be submitted 30 days before the end of the approval period. Failure to do so may result in processing delays and/or non-renewal.
2. **Completion Report:** Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB Office.
3. **Adverse Events:** Adverse events must be reported to the IRB Office immediately.
4. **Amendments:** Changes to the protocol must be requested by submitting an Amendment to the IRB Office for review. The Amendment must be approved by the IRB before being implemented.
5. **Informed Consent:** Information must be presented to enable persons to voluntarily decide whether or not to participate in the research project.

This electronic document provides notification of the review results by the Institutional Review Board.

VITA

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